User Manual

LVRSys™

Low Voltage Regulator System™

(Low voltage regulator system)

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1. Overview

This User Manual is a summary of the information needed for the installation, putting into operation and operation of the low-voltage regulator.

Read the User Manual in its entirety and do not use the product unless you have understood what you read.

1.1 Target group

The User Manual is intended for skilled technicians as well trained and certified operators.

The contents of this User Manual must be accessible to people tasked with the installation and operation of the system.

1.2 Warnings

Structure of the warnings

Warnings are structured as follows:

⚠ SIGNAL WORD	**Nature and source of the danger.** Consequences in the event of non-observance. ➲ Actions to avoid the danger.

Types of warnings

Warnings are distinguished by the type of danger they are warning against:

⚠ DANGER!	Warns of an immediately impending danger that can result in death or serious injuries when not avoided.

⚠ WARNING!	Warns of a potentially dangerous situation that can result in death or serious injuries when not avoided.

⚠ CAUTION!	Warns of a potentially dangerous situation that can result in fairly serious or light injuries when not avoided.

NOTICE:	Warns of a potentially dangerous situation that results in material or environmental damage when not avoided.

1.3 Tips

Tips on the appropriate device use and recommendations.

1.4 Other symbols

Instructions

Structure of the instructions:

➲ Instructions for an action.

↳ Indication of an outcome, if necessary.

Lists

Structure of unnumbered lists:

- List level 1
  - List level 2

Structure of numbered lists:

1) List level 1
2) List level 1
   1. List level 2
   2. List level 2

1.5 Applicable documentation

For the safe and correct use of the product, observe the additional documentation that is delivered with the system as well as the relevant standards and laws.

1.6 Storage

Store the user manual, including the supplied documentation, readily accessible near the system.

2. Scope of Delivery/Options

2.1 Scope of delivery standard system

- Concrete base (for outdoor installation)
- Steel base (for indoor installation)
- LVRSys™ switch cabinet
- LVRSys™ user manual
- Circuit diagram LVRSys™ switch cabinet

2.2 Options

2.2.1 Modifications bus system/*BYPASS*

- Additional inflows (integration of a cable distribution cabinet)
- Additional outflows (integration of a cable distribution cabinet)
- NH separator in a different version.

Larger modifications to the bus system increase the size of the switch cabinet.

2.2.2 Voltage/current measurements

In the standard system, the regulator only needs the output voltages of the LVRSys™. The output has 2 x 3 test connections. Measurements can be extended by:

- Voltage taps at the input of the LVRSys™
- Current measurement/converter at the input of the LVRSys™
- Current measurement/converter at the output of the LVRSys™

2.2.3 Power output

- Schuko socket with FI fuse.

2.2.4 External components

- Measuring devices, remote controls, etc… can be installed in the cabinet upfront if so agreed in the planning phase.

2.2.5 Power quality measurement

- Power quality measurement at LVRSys™ input
- Power quality measurement at LVRSys™ output

2.2.6 Pivot lever locking cylinder

- Modifications can be made to the locking system on request.

3. Safety instructions

- Follow the operating instructions.
- Keep the operating instructions with the device.
- Do not operate the device if it is not in impeccable condition.
- Make sure the device is only operated by qualified personnel.
- Connect the device as specified.
- Make sure the device is not operated outside the design limits (see Sec. 4 Technical Data).
- Do not use the device in environments where explosive gases, dust or fumes occur
- Make sure the front covers are present and close properly.
- Clean the device only with commercially available cleaning agents.

4. Technical Data

Ambient temperature	-40°C to 45°C
Maximum permitted air temperature in the switch cabinet	70 °C
Altitude of the installation (NN)	< 2000 m
Safety class	IP 54
Rated voltage U_N	400 V/230 V ±20% (L-L/LE)
Rated current I_N	80 A (55 kVA system) 160 A (110 kVA system) 250 A (175 kVA system) 315 A (250 kVA system) 580 A (400 kVA system)
Rated frequency f_N	50 Hz
Efficiency	99.5% - 99.7%
Standard regulation range Extended regulation range	±6% of U_N ±10% of U_N
Step number/Distance 6% Step number/Distance 10%	9/1.5% 9/2.5%
Switch cabinet dimensions W/D/H	120 cm/40 cm/135 cm (55 kVA system ±6%) 120 cm/40 cm/135 cm (55 kVA system ±10%) 120 cm/40 cm/135 cm (110 kVA system ±6%) 140 cm/40 cm/145 cm (110 kVA system ±10%) 140 cm/40 cm/145 cm (175 kVA system ±6%) 140 cm/40 cm/145 cm (175 kVA system ±10%) 160 cm/40 cm/155 cm (250 kVA system ±6%) 160 cm/40 cm/155 cm (250 kVA system ±10%) 160 cm/40 cm/155 cm (400 kVA system ±6%)
Weight switch cabinet	200 kg (55 kVA system ±6%) 240 kg (55 kVA system ±10%) 230 kg (110 kVA system ±6%) 280 kg (110 kVA system ±10%) 320 kg (175 kVA system ±6%) 400 kg (175 kVA system ±10%) 430 kg (250 kVA system ±6%) 550 kg (250 kVA system ±10%) 540 kg (400 kVA system ±6%)

Dimensions grounding base W/D/H	120 cm/40 cm/100 cm (55 kVA system ±6%) 120 cm/40 cm/100 cm (55 kVA system ±10%) 120 cm/40 cm/100 cm (110 kVA system ±6%) 140 cm/50 cm/100 cm (110 kVA system ±10%) 140 cm/50 cm/100 cm (175 kVA system ±6%) 140 cm/50 cm/100 cm (175 kVA system ±10%) 160 cm/50 cm/100 cm (250 kVA system ±6%) 160 cm/50 cm/100 cm (250 kVA system ±10%) 160 cm/50 cm/100 cm (400 kVA system ±6%)
Weight grounding base	260 kg (55 kVA system ±6%) 260 kg (55 kVA system ±10%) 260 kg (110 kVA system ±6%) 280 kg (110 kVA system ±10%) 280 kg (175 kVA system ±6%) 280 kg (175 kVA system ±10%) 300 kg (250 kVA system ±6%) 300 kg (250 kVA system ±10%) 300 kg (400 kVA system ±6%)
Power consumption control units	100 mA (230 V)
Cooling	- passive (convection via switch cabinet housing) - active (redundant ventilation system) (depending on the application conditions)
Short-circuit impedance u_k	0.22% (55 kVA system ±6%) 0.26% (55 kVA system ±10%) 0.15% (110 kVA system ±6%) 0.28% (110 kVA system ±10%) 0.14% (175 kVA system ±6%) 0.24% (175 kVA system ±10%) 0.14% (250 kVA system ±6%) 0.21% (250 kVA system ±10%) 0.13% (400 kVA system ±6%)
Maximum phasing duration	30 ms
Noise emissions	< 30 dB(A)
Electromagnetic immunity	DIN EN 61000-6-1
Electromagnetic interference	DIN EN 61000-6-3
Assembly instructions	DIN EN 61439-1/5
Low voltage directive	2014/35/EU

Table 4-1 Technical data

5. Intended use

This product is designed exclusively to regulate voltage at the low voltage level (400V L-L).

6. Description and Principle of Operation

The LVRSys™ regulator is based on a linear regulator. By coupling and uncoupling two transformers with a selected transfer ratio, the output voltage can be regulated in steps of 1.5%/2.5%. The maximum control range is ±6%/±10%.

The transformers are controlled by thyristors. The stages of the transformers are determined by the thyristors' switching settings.

Step	Transformer 1.5%/2.5%	Transformer 4.5%/7.5%
-6%/-10%	-1.5%/-2.5%	-4.5%/-7.5%
-4.5%/-7.5%	0%/0%	-4.5%/-7.5%
-3%/-5%	+1.5%/+2.5%	-4.5%/-7.5%
-1.5%/-2.5%	-1.5%/-2.5%	0%/0%
0%/0%	0%/0%	0%/0%
+1.5%/+2.5%	+1.5%/+2.5%	0%/0%
+3%/+5%	-1.5%/-2.5%	+4.5%/+7.5%
+4.5%/+7.5%	0%/0%	+4.5%/+7.5%
+6%/+10%	+1.5%/+2.5%	+4.5%/+7.5%

Table 6-1 Generation of the voltage levels

The control signals for the thyristors are generated by driver circuits that switch them intelligently. By monitoring the magnetic flux in the transformers, the transformers can be switched without voltage dips, current increases and without generating harmonics.

The step change required is output by the controller. The controller can determine the step based on the bus bar voltage or the output currents.

All three phases are regulated independently of one another. This helps improve the symmetry of the grids.

The safety contactor activates automatically in the event of a failure. This ensures that the transformers are shorted although the low-voltage grid is still operated unregulated.

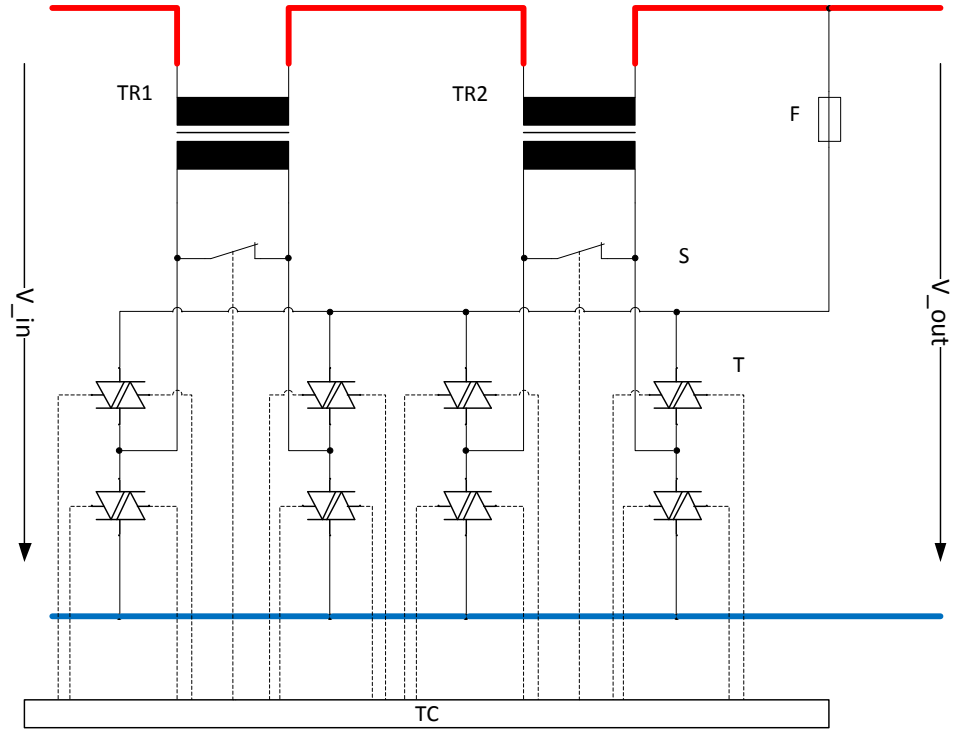


Figure 6-1 Single-phase functional diagram

F	Fuse
S	Safety contactor (NCC principle)
T	Thyristor
TC	Thyristor control
V_in	Unregulated input voltage
V_out	Regulated output voltage

Table 6-2 Explanation of the abbreviations

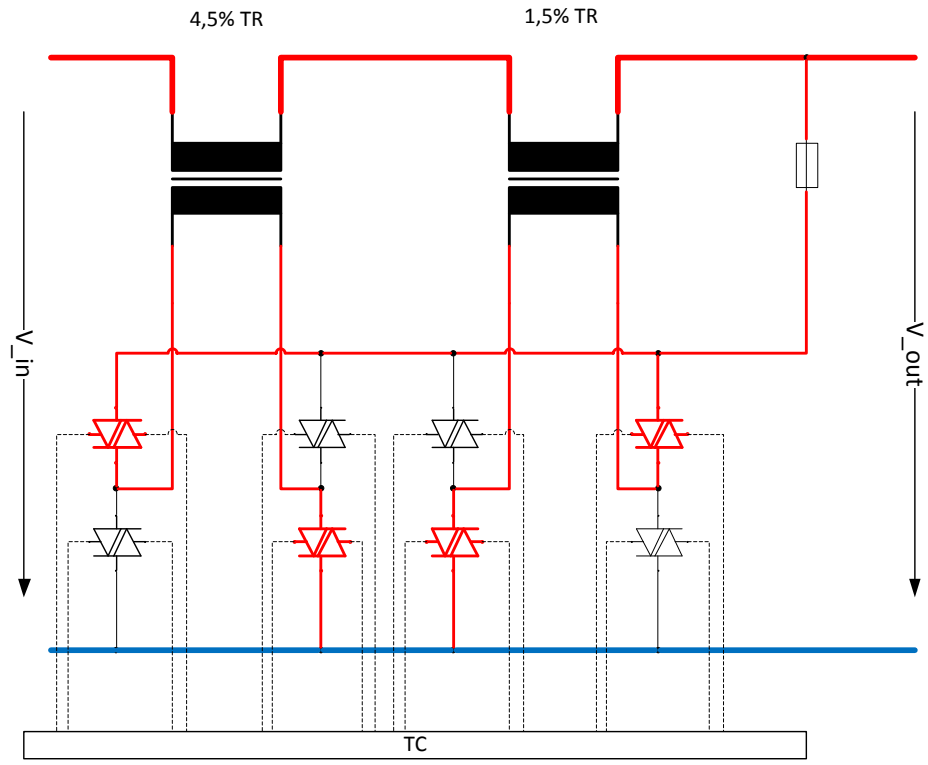


Figure 6-2 Example of 3% voltage reduction

In the example shown in Figure 6-2, the output voltage is reduced by 3% compared with the input voltage. The transformer *4.5% TR* converts the primary voltage, which is switched by thyristors, in a negative direction and subtracts 10.35 V (4.5% of 230 V) from the output voltage. The transformer *1.5% TR* converts the primary voltage in a positive direction and adds 3.45 V (1.5% of 230 V) to the output voltage.

7. Installation

7.1 System overview

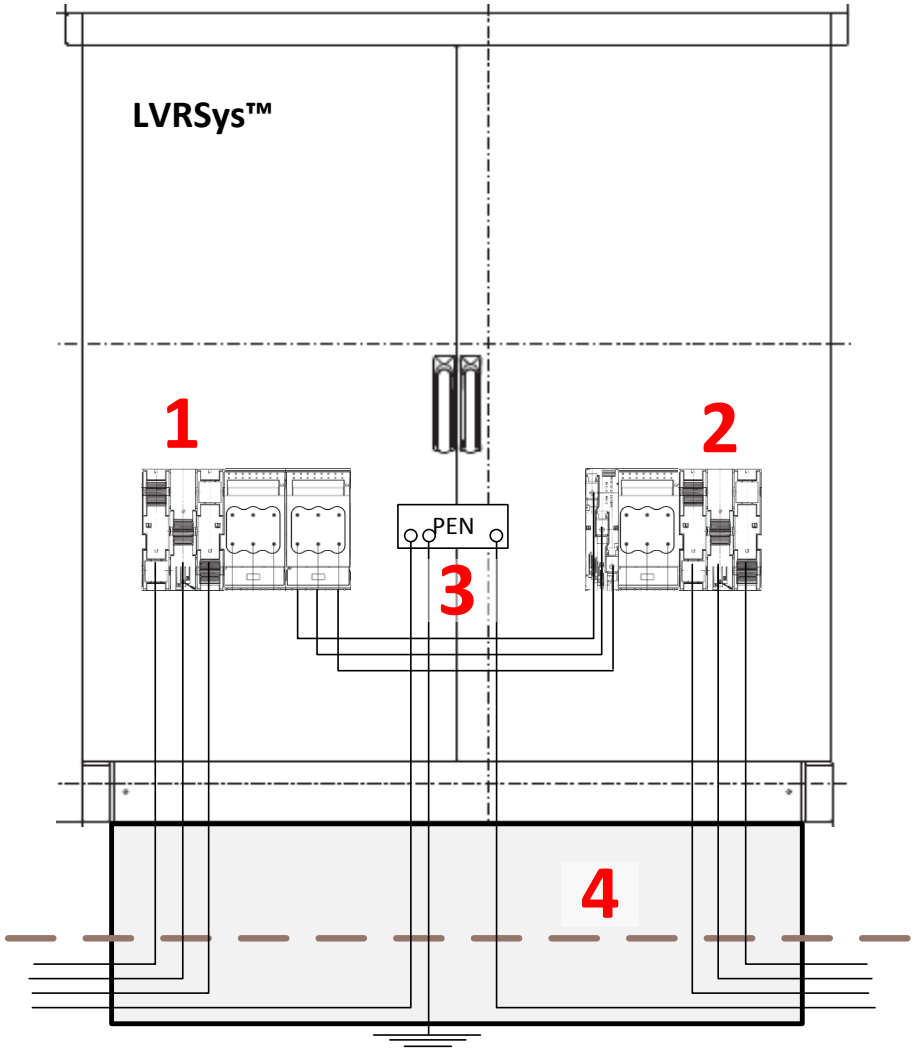


Figure 7-3 LVRSys Connection overview of low-voltage cables 55 kVA (6%/10%)/110 kVA (6%)

1	Terminal block for cable input (for copper and aluminium conductors; Cross section 95 mm² - 185 mm²; Allen 4 mm; torque 12 - 15 Nm)
2	Terminal block for cable output (for copper and aluminium conductors; Cross section 95 mm² - 185 mm²; Allen 4 mm; torque 12 - 15 Nm)
3	*PEN* bus (3 x rivet nut M12)
4	Concrete base

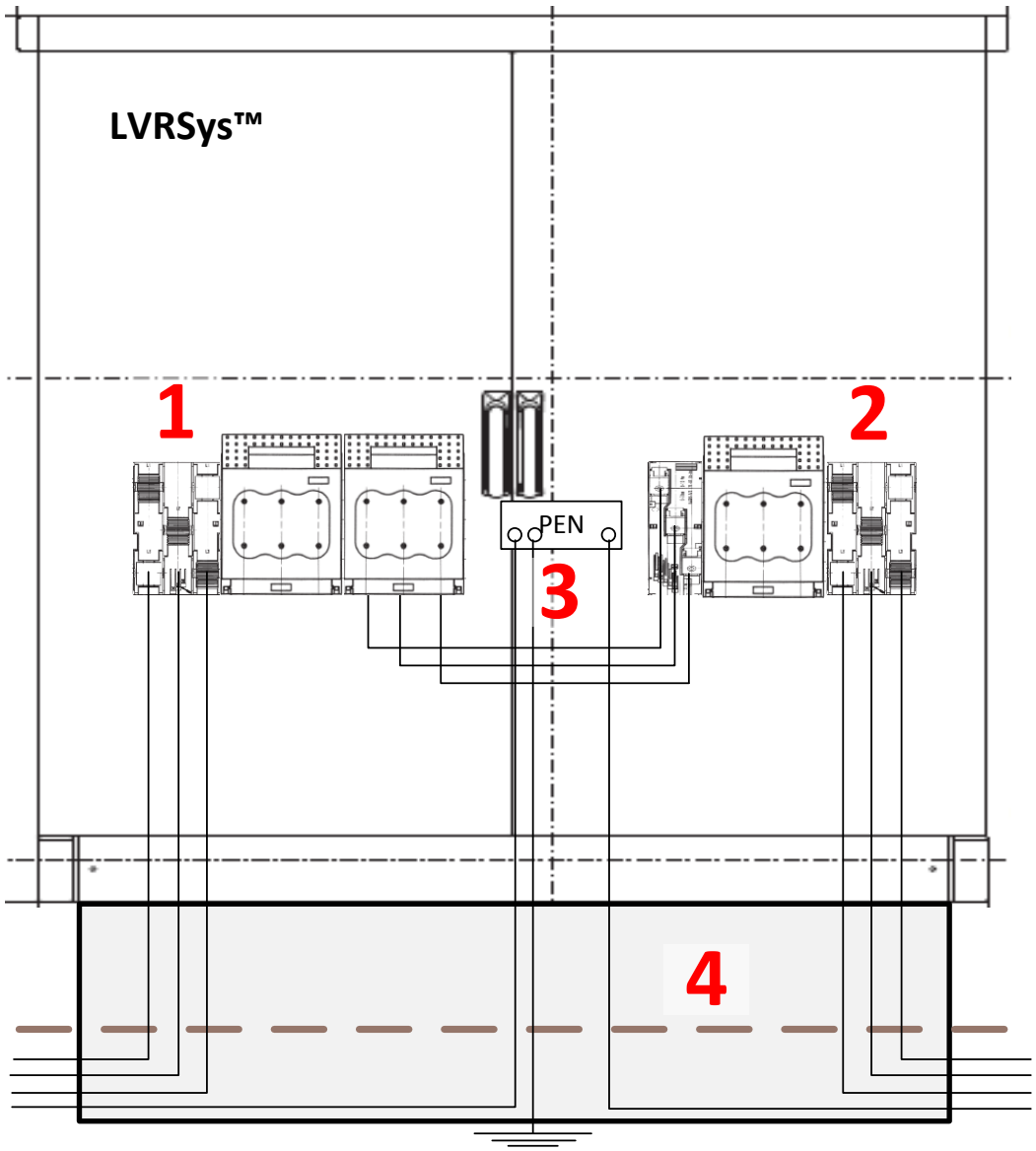


Figure 7-4 LVRSys connection overview of low-voltage cables 110 kVA (10%)/175 kVA 6%/10%)

1	Terminal block for cable input (for copper and aluminium conductors; Cross section 95 mm² - 185 mm²; Allen 4 mm; torque 12 - 15 Nm)
2	Terminal block for cable output (for copper and aluminium conductors; Cross section 95 mm² - 185 mm²; Allen 4 mm; torque 12 - 15 Nm)
3	*PEN* bus (3 x rivet nut M12)
4	Concrete base

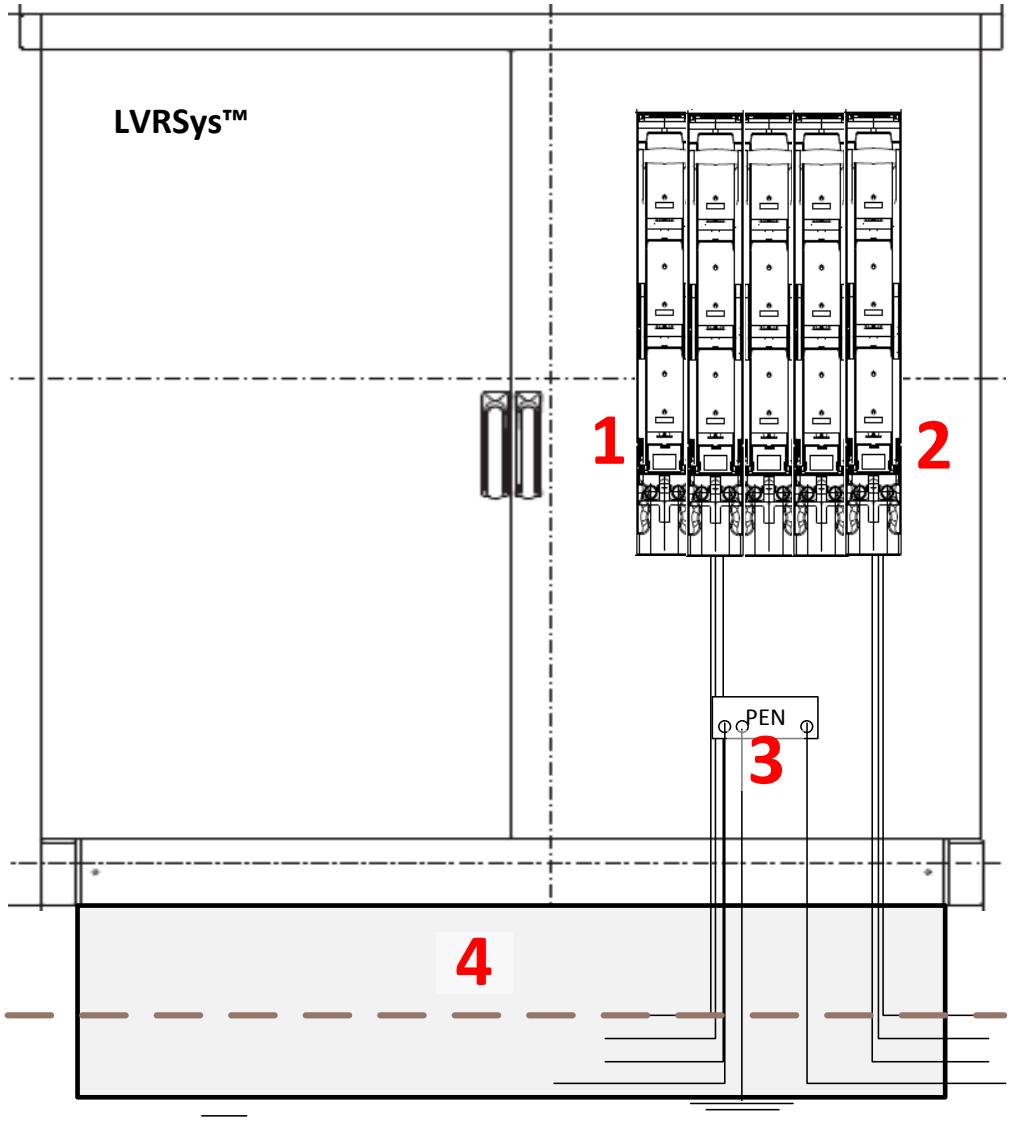
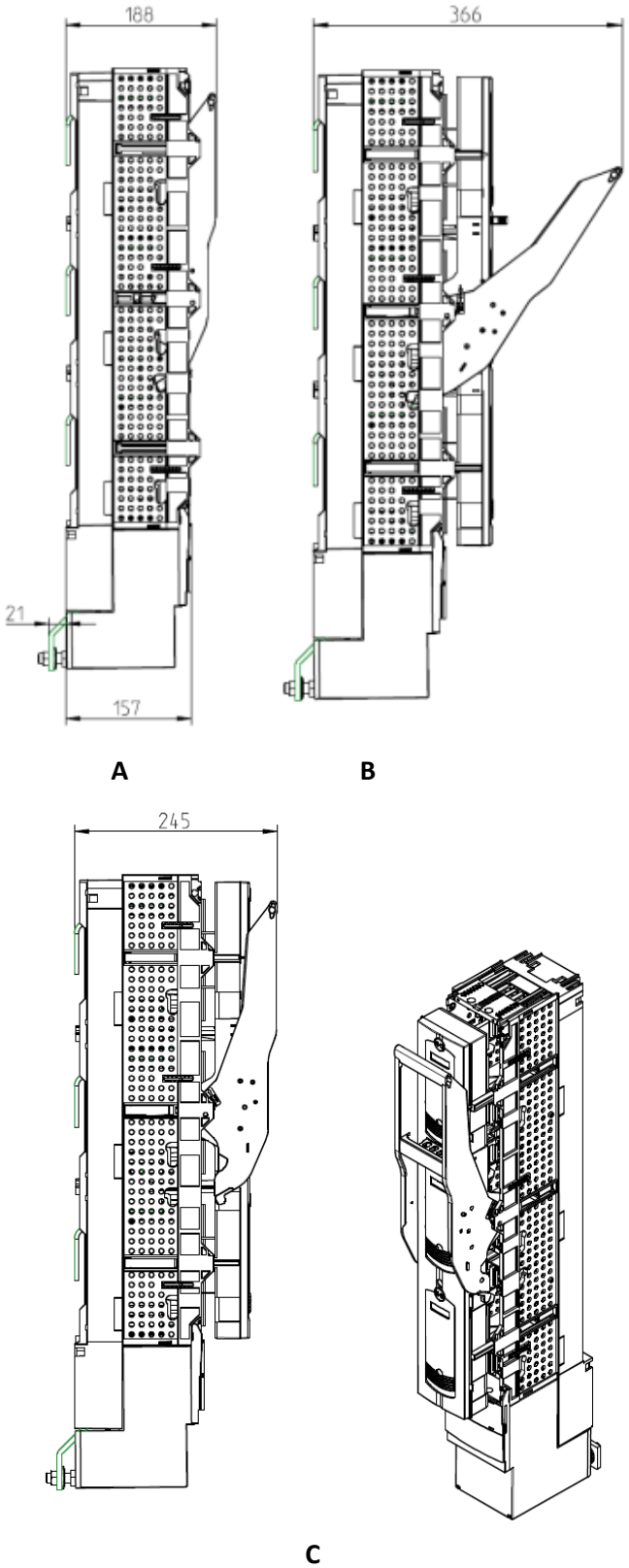


Figure 7-5 LVRSys connection overview of low-voltage cables 250 kVA (6%/10%)/400kVA (6%)

1	Switch disconnector fuse for cable input (tubular cable lug and rivet nut M12)
2	Switch disconnector fuse for cable output (cable lug and rivet nut M12)
3	*PEN* bus (3 x rivet nut M12)
4	Concrete base



Switch disconnector fuse:

A) Closed

B) Open

C) Disconnected

Figure 7-6 Position switch disconnector fuse

7.2 Packaging and Transport

7.2.1 Packaging

SHOCKWATCH
MADE IN THE USA
WARNING
HANDLE WITH CARE
VORSICHT
STOSSEMPFINDLICH
ROUGH HANDLING WILL CHANGE THE INDICATOR TO BRIGHT RED. IF SHOCKWATCH IS RED NOTE ON BILL OF LADING. INSPECTION MAY BE WARRANTED.
UNSACHGEMÄSSE BEHANDLUNG FÄRBT DEN INDIKATOR ROT. ROTEN INDIKATOR IM FRACHTBRIEF VERMERKEN. ENTFERNEN DES SHOCKWATCH BEDEUTET ROT.
Ströbel
L-65 (25g)
210366
24/11/2014
2013

Figure 7-1 Packaging and shock stickers

To protect the system, the packaging consists of USB plates.

- Check the shock stickers before opening.
- For *red* stickers:
- Do not remove the packaging.
- Contact A. Eberle GmbH & Co. KG.

7.2.2 Transport on pallets

⚠ CAUTION!	**Switch cabinet can be damaged if handled incorrectly during transport!** ➲ Only transport LVRSys™ in an upright position. ➲ Make sure the switch cabinet cannot topple over. ➲ Fastening mounting devices on the board wall.

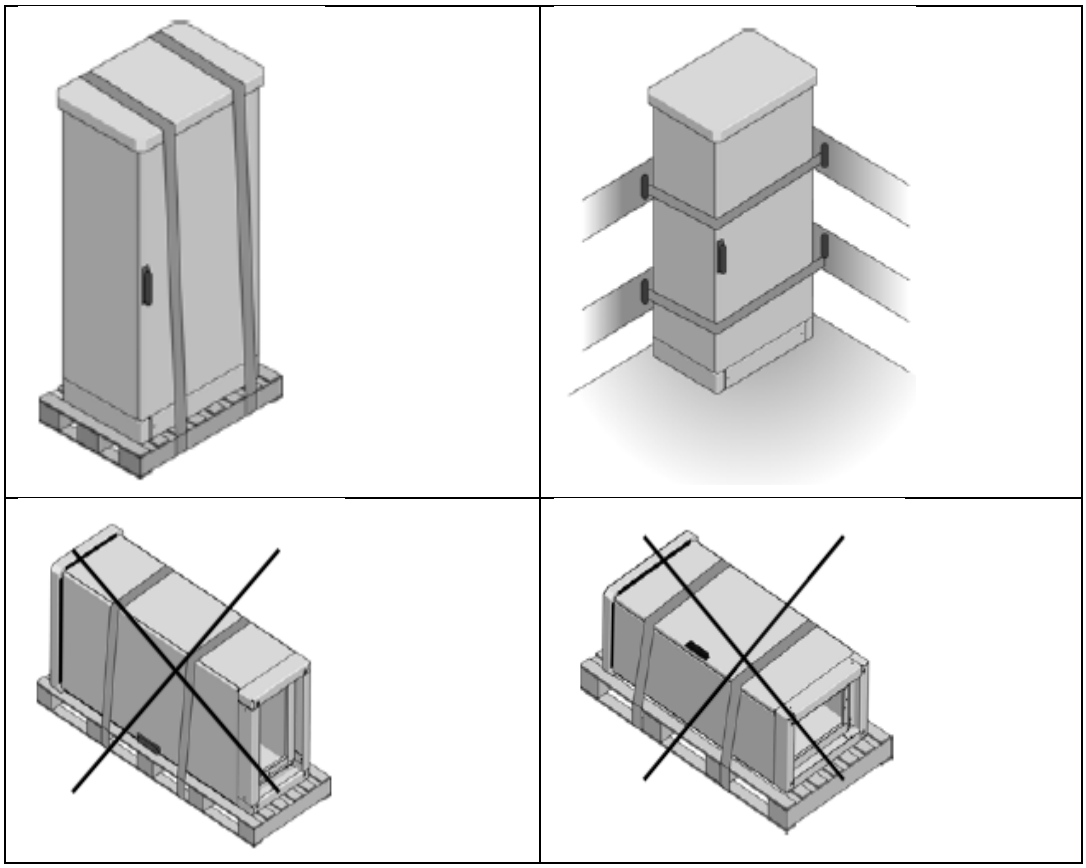


Figure 7-2 Transporting the cabinet by lorry

7.2.3 Transport by crane

Removing the hood:

- Loosen the screws at the front (1).
- Lift the hood at the front (2).
- Push the hood to the back (3).
- Lift the hood upward (4).

Installing the hood:

- Lower the hood from above (5).
- Push the hood to the front (6).
- Fasten the screws at the front (7).

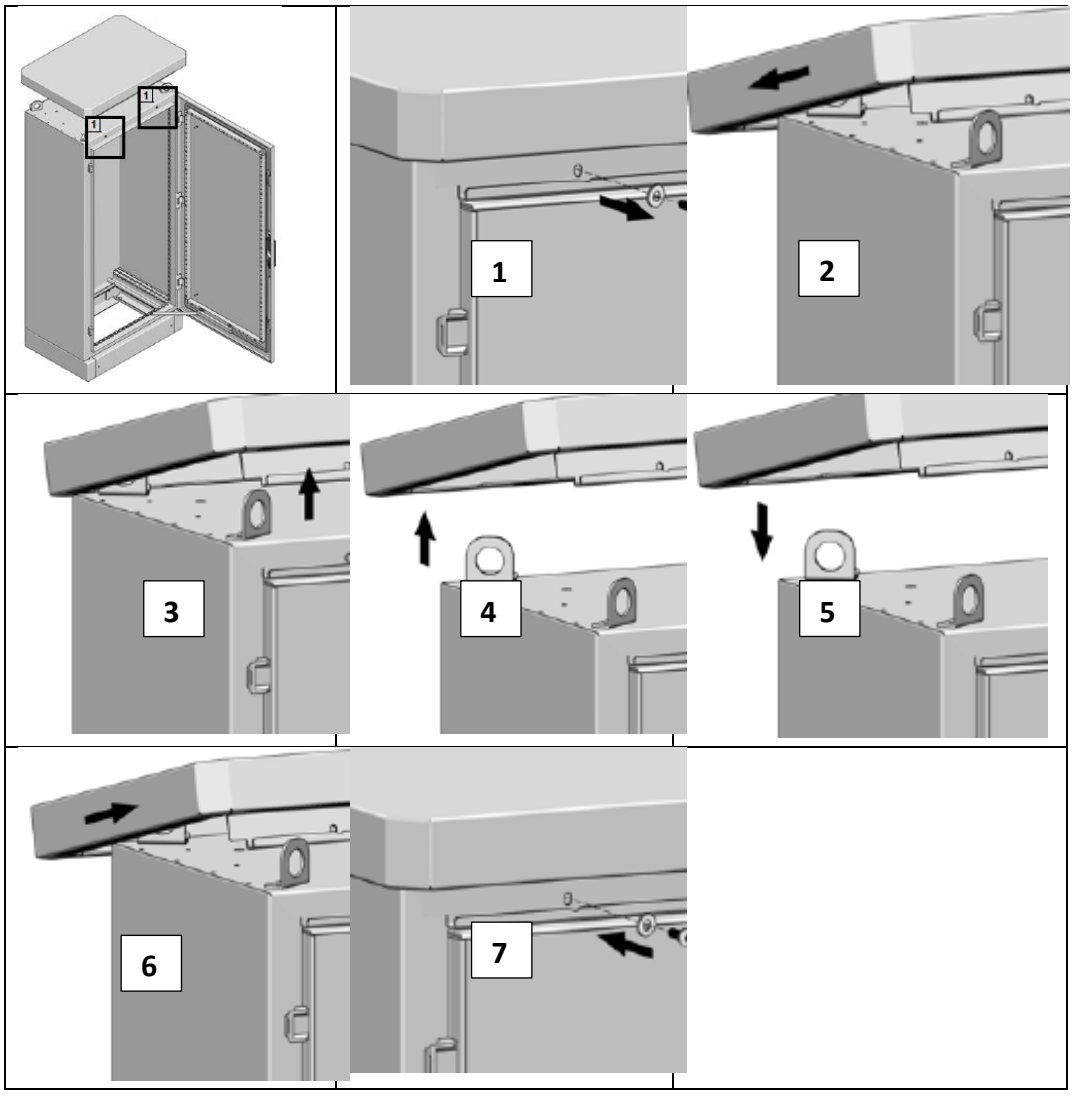


Figure 7-3 Installing and removing the hood

The screws can be loosened and fastened with a TX 25 screwdriver. The tightening torque may not exceed 6 Nm.

DANGER!	**Falling switch cabinet is a danger to life!**
	➲ Make sure no one is below a hanging load.

CAUTION!	**Falling switch cabinet can damage the system!**
	➲ Secure the LVRSys™ with all of the transport lugs. ➲ Load the transport lugs only with vertical load (maximum deviation 60°). ➲ Do not lift the LVRSys™ with a jolt.

➲ Use all four transport lugs.

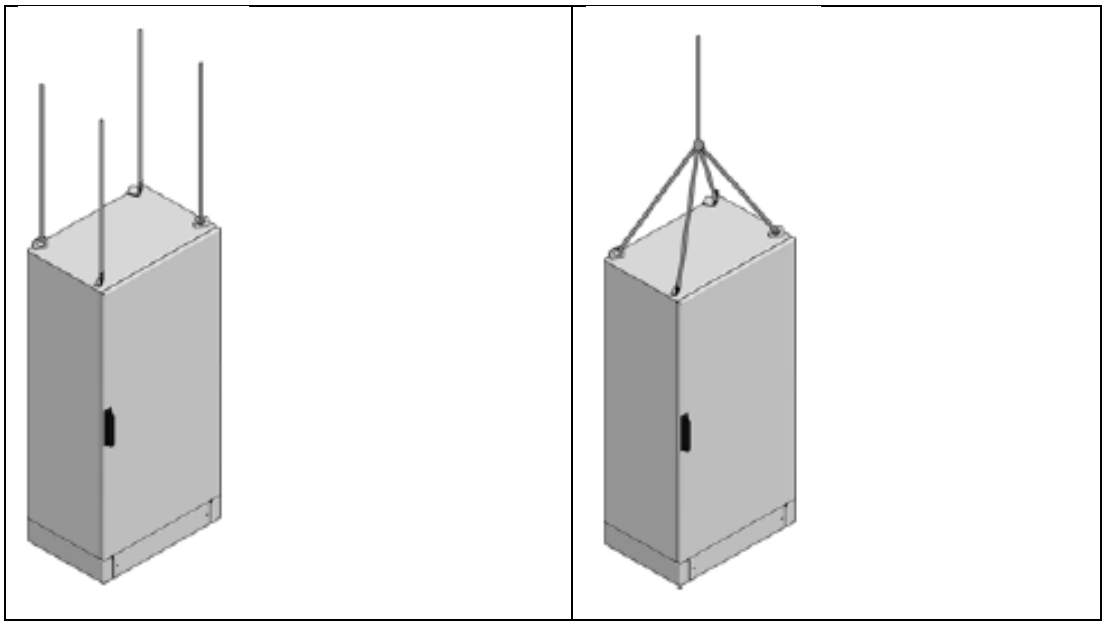


Figure 7-4 Transport lugs

7.3 Cover

Installing and removing the locking cylinder:

- Turn the cover cap to the right to open it (1).
- Insert the key in the locking cylinder and turn right to open (2).
- Unscrew fastening screw (M5) from the locking cylinder (3).
- Pull out the locking cylinder towards the switch cabinet (4).
- Slide in the new locking cylinder (5).
- Screw fastening screw (M5) into the locking cylinder (6).
- Insert the key in the locking cylinder and turn left to lock (7).
- Turn cover cap left to close (8).

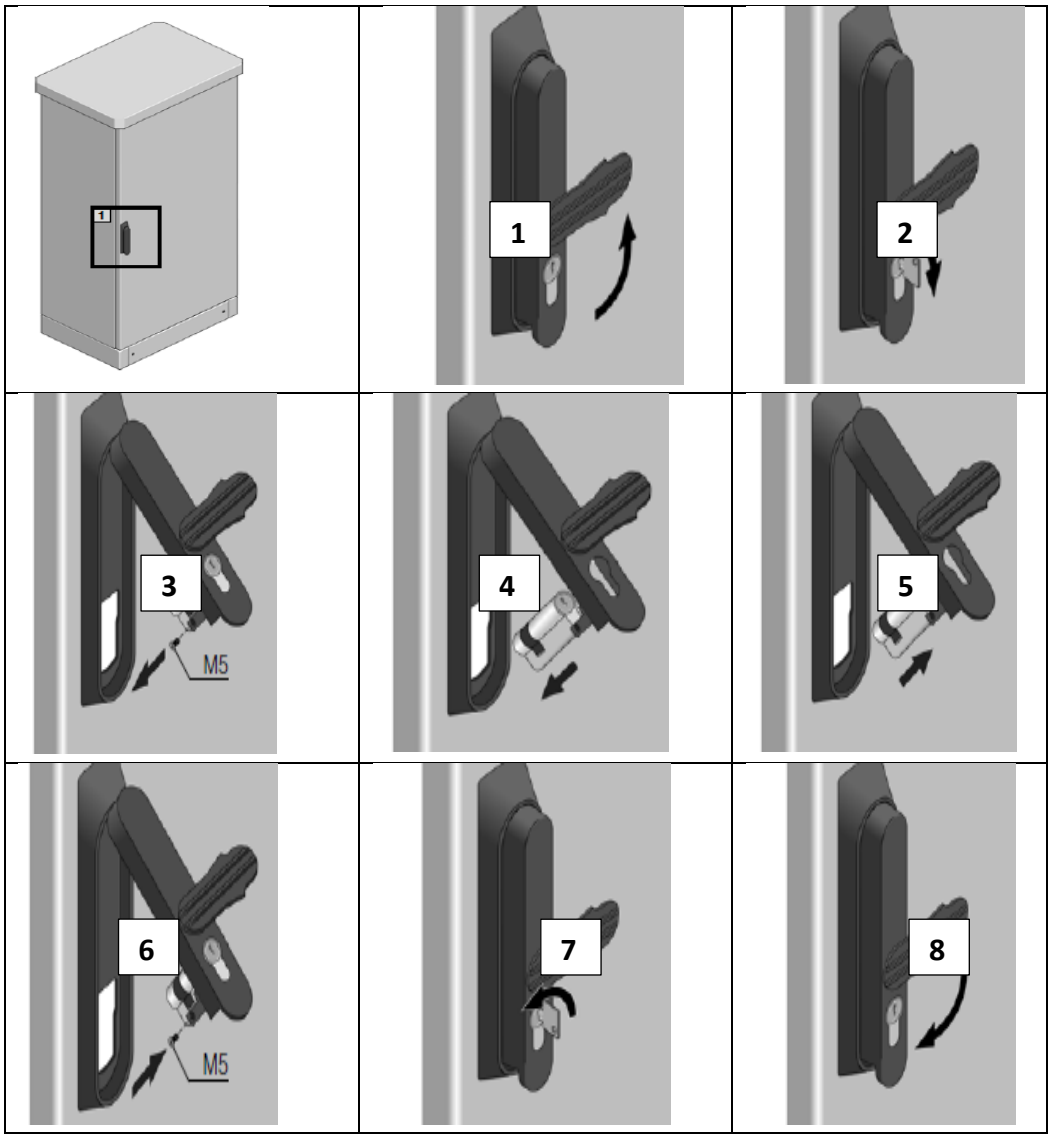


Figure 7-5 Installing and removing the locking cylinder

The screws can be loosened and fastened with a Philips (crosshead) screwdriver. The tightening torque is between 1.5 Nm and 2.5 Nm.

7.4 LVRSys™ assembly

- Make sure there is sufficient ventilation to extract the heat.
- Observe the following minimum distances:
  - 10 cm to walls or other switch cabinets
  - 50 cm to the ceiling
  - 100 cm to 120 cm near doors.
- Avoid direct sunlight.

7.4.1 Base hole for grounding base

- Cut out a base hole that is 95 to 100 cm deep.
- Found it with 30 cm of broken stones and gravel.
- Install the grounding base (see Sec. 7.4.2 Mounting the grounding base).
- Install the grounding base.

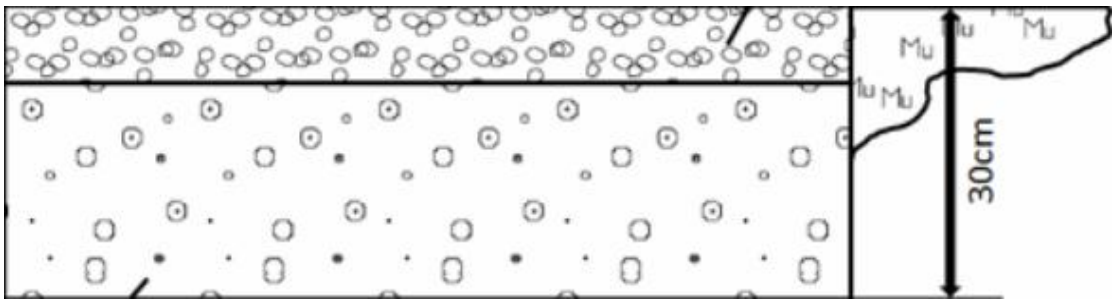


Figure 7-6 Founding

7.4.2 Mounting the grounding base

Two people are needed to set up the base.

Required tools

- Spirit level
- Wrench 13 and 19, 25 Nm.

➲ When edging the base with flagging or similar material, a minimum distance to the base of 5 cm must be observed as an expansion gap.

➲ Do not bring vibratory equipment in contact with the base.

➲ To avoid the collection of condensation around the base, seal the final layer of filling in the base with suitable material.

Recommendation:

- Dry fine gravel as the bottom layer
- Dry river sand as the middle layer
- Poor concrete, gas concrete or styrofoam as the final layer.

The grounding base is made of light-weight concrete and consists of:

- Foundation plate
- Two side components
- Two split base plates
- Installation material
- Fastening screws.

To give the sides more stability, support them with earth-moist concrete.

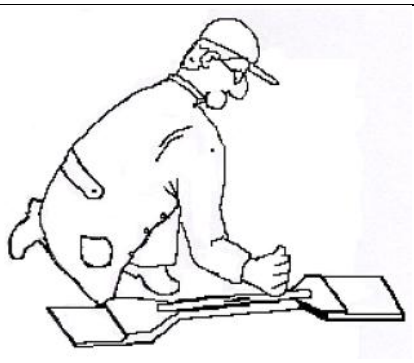
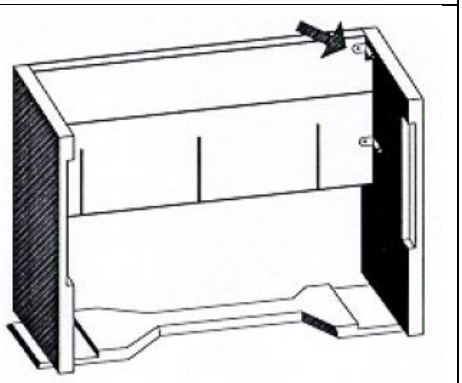
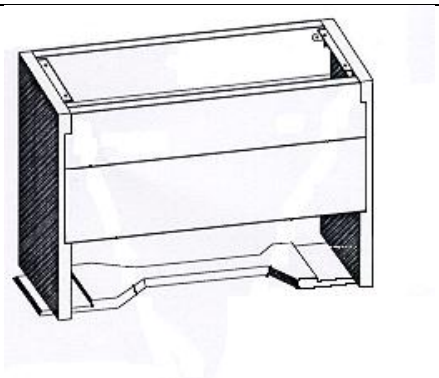
➲ Align the foundation plate with recesses facing upward	
➲ Place the side components with notches facing upward on the foundation plate.	
Fasten the rear panel: ➲ Connect the larger plate at the bottom with two screws and brackets to the side components. ➲ Connect the smaller plate at the top with two screws and brackets to the side components.	
➲ Pull through the wiring. ➲ Of the two-part front panel, first fasten the larger plate at the bottom with two screws and brackets to the side components. Then connect the smaller plate at the top with two screws and brackets to the side components. ➲ Installation depth of the grounding base ca. 70 cm	

Figure 7-7 Installing the grounding base

7.4.3 Installing the LVRSys™ on a concrete base

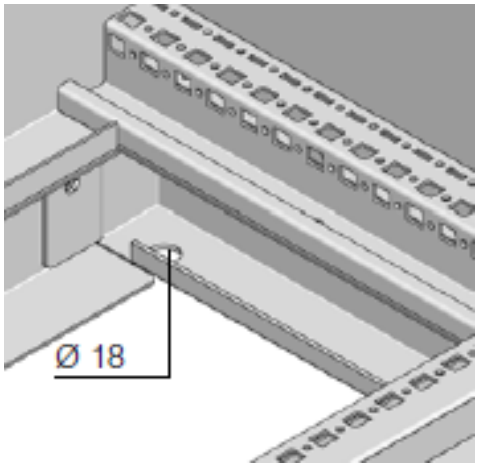


Figure 7-8 Mounting ducts

- Connect the switch cabinet through four mounting ducts with the grounding base.
- Only use the provided screws M 12 x 25 mm.

7.4.4 Local grounding point

The operator of the installation must ensure that the local grounding point is conform with DIN 18014 or DIN EN 62305-3. Connect the local grounding point to the *PEN* bus (see Sec. 7.5 Connecting the low-voltage cable).

7.5 Connecting the low-voltage cable

⚠ DANGER!	**Danger of electric shock!**
	➲ Make sure the LVRSys™ is de-energized before connecting it.

⚠ CAUTION!	**Destruction of components due to overload!**
	➲ Use cable clasps in the LVRSys™ system's inputs and outputs.

⚠ CAUTION!	**Destruction of components due to overload!**
	➲ Only switch on the low voltage grid in *BYPASS* mode. (See Sec. 8.2 Taking LVRSys™ out *of* operation and *BYPASS* mode).

Sequence:

- ➲ Isolate the low voltage grid.
- ➲ Clamp L1/L2/L3 according to DIN EN 61439 (See Sec. 7.1 System overview).
- ➲ Clamp *PEN*/local cabinet grounding according to DIN EN 61439 (See Sec. 7.1 System overview).
- ➲ Install the cable clips on C profile rails under input and output.
- ➲ Couple the low voltage grid.

8. Putting the LVRSys™ into operation and taking it out of operation

⚠ DANGER!	**Danger of electric shock!** ➲ Never open the NH separator partially. ➲ Always use the handle to open the lid.

NH fuses are intended exclusively for use by skilled electricians or people trained in electrotechnical work, see IEC 60269-2.

The following must be observed when switching devices:

- ➲ Make sure the device is put into and taken out of operation and operated by skilled electricians only or people who have been trained according to VDE 0105-100.
- ➲ Use the handle to operate the fuse lid.
- ➲ Before switching on, make sure the fuse lid is stored or led in the open position.
- ➲ If the lid is partially open, fuse units can be under current.

8.1 Putting the LVRSys™ into operation

The initial position is:

- Closed *BYPASS*.
- Open input (*LVRSys IN*).
- Open output (*LVRSys OUT*).
- The regulator in position *Off*.

⚠ CAUTION!	**Destruction of components due to overload!**
	➲ Only switch on the LVRSys™ according to the described process.

➲ Close *LVRSys IN*.

➲ Close *LVRSys OUT.*

➲ Open *LVRSys BYPASS*.

➲ Switch regulator to *ON* position (See Sec. 9.2.2 Switch).

↳ Regulator automatically moves up.

↳ LVRSys™ is active.

↳ Local network is regulated over LVRSys™.

8.2 Taking LVRSys™ out of operation and *BYPASS* mode

The initial position is:

- Closed input (*LVRSys IN*).
- Closed output (*LVRSys OUT*).
- The regulator in position *ON*.
- Open *BYPASS*.

⚠ CAUTION!	**Destruction of components due to overload!**
	➲ Isolate the LVRSys™ only according to the described process.

➲ Switch regulator to *OFF* position (see Sec. 9.2.2 Switch).

↳ Secondary electronics (regulator/actuator/contactors) are de-energized.

↳ Transformers are short-circuited through opener contactors.

➲ Close *LVRSys BYPASS*.

➲ Open *LVRSys OUT*.

➲ Open *LVRSys IN*.

↳ LVRSys™ is isolated from the grid.

↳ *BYPASS* is active.

↳ The local grid is supplied through the *BYPASS*.

9. Operation/Regulator operation

9.1 Operating Conditions Temperature

Installation	Ambient temperature	Solar radiation	Operation
55 kVA ±6%/±10%	≤45°C	none	up to rated output
	≤35°C	direct	up to rated output
	≤45°C	direct	up to 0.8 x rated output
110 kVA ±6%	≤45°C	none	up to rated output
	≤35°C	direct	up to 0.8 x rated output
	≤45°C	direct	up to 0.7 x rated output
110 kVA ±10%	≤45°C	none	up to 0.9 x rated output
	≤35°C	direct	up to 0.7 x rated output
	≤45°C	direct	up to 0.6 x rated output
175 kVA ±6%	≤45°C	none	up to 0.9 x rated output
	≤35°C	direct	up to 0.7 x rated output
	≤45°C	direct	up to 0.6 x rated output
175 kVA ±10%	≤45°C	none	up to 0.8 x rated output
	≤35°C	direct	up to 0.6 x rated output
	≤45°C	direct	up to 0.5 x rated output
250 kVA ±6%	≤45°C	none	up to 0.9 x rated output
	≤35°C	direct	up to 0.6 x rated output
	≤45°C	direct	up to 0.5 x rated output
250 kVA ±10%	≤45°C	none	up to 0.8 x rated output
	≤35°C	direct	up to 0.6 x rated output
	≤45°C	direct	up to 0.5 x rated output
400 kVA ±6%	≤45°C	none	up to 0.9 x rated output
	≤35°C	direct	up to 0.7 x rated output
	≤45°C	direct	up to 0.6 x rated output
630 kVA ±6%	≤45°C	none	up to 0.9 x rated output
	≤35°C	direct	up to 0.7 x rated output
	≤45°C	direct	up to 0.6 x rated output

Table 9-1 Operating conditions for pure passive convection

- Using an active ventilation system, the installations can be operated up to 0.8 x rated output in temperatures up to 45°C and direct sunlight.
- LVRSys™ components are designed for temperatures inside the switching cabinet of us to 70°C.

- NH fuse units are limiting elements that cannot be operated at their rated output at temperatures over 40°C.

9.2 Indicator lamps and switches

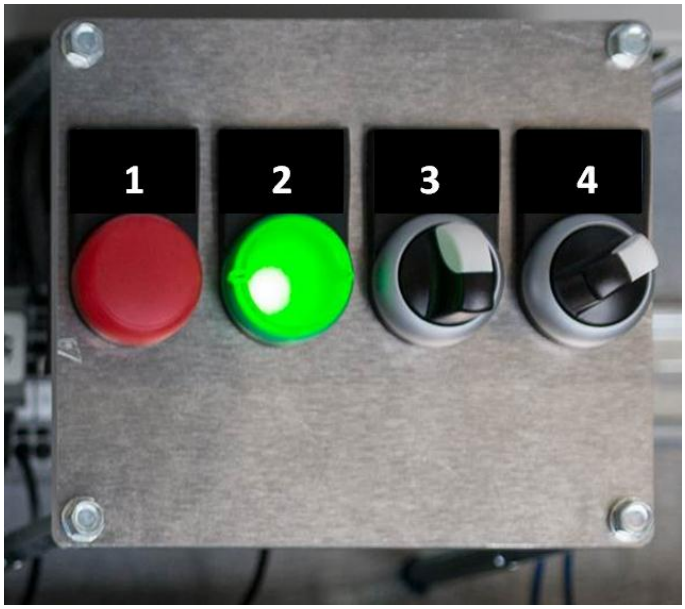


Figure 9-1 Lamps and switches

Description:

1) Lamp *Failure*
2) Lamp *Operation*
3) Switch service switch
4) Switch *Switch system on*

9.2.1 Indicator lamps

The *red* and *green* indicator lamps show that state the system is in:

- *Red*: Error state
- *Green*: Error-free state; system is in operating mode.

➲ You must contact A. Eberle GmbH & Co. KG. when an indicator lamp illuminates *red*.

➲ Note the error code (Sec.9.12.2 LOG ERR).

➲ Take the system out of operation as described in Sec. 8.2 Taking LVRSys™ out *of* operation and *BYPASS* mode.

➲ You must follow A. Eberle GmbH & Co. KG.'s instructions when putting the system back into operation.

9.2.2 Switch

The switch settings create the following states:

- Switch*Switch system on*:
  - Switch to the right: System on
  - Switch upward: System off

- Switch *service switch*:
  - Switch to the right: Switch service active:
  - Switch upward: Switch service inactive:

    ↳ The use of the *service switch* is reserved for firmware updates.

9.3 Boot process

➲ Activating the *System on* switch automatically starts the regulator's boot process.

↳ After 25 seconds, the display shows *Boot...*.

↳ After completing the boot process (ca. 45 sec), the regulator is in *'Automatic'* mode.

The boot process must be completed in order to perform all other activities such as configuration, changing the display pages, etc.

9.4 Menu navigation

By default, the regulator is in *Automatic* mode when operating error free.

The main display shows the external conductor's three phase voltages and the current tap for each phase.

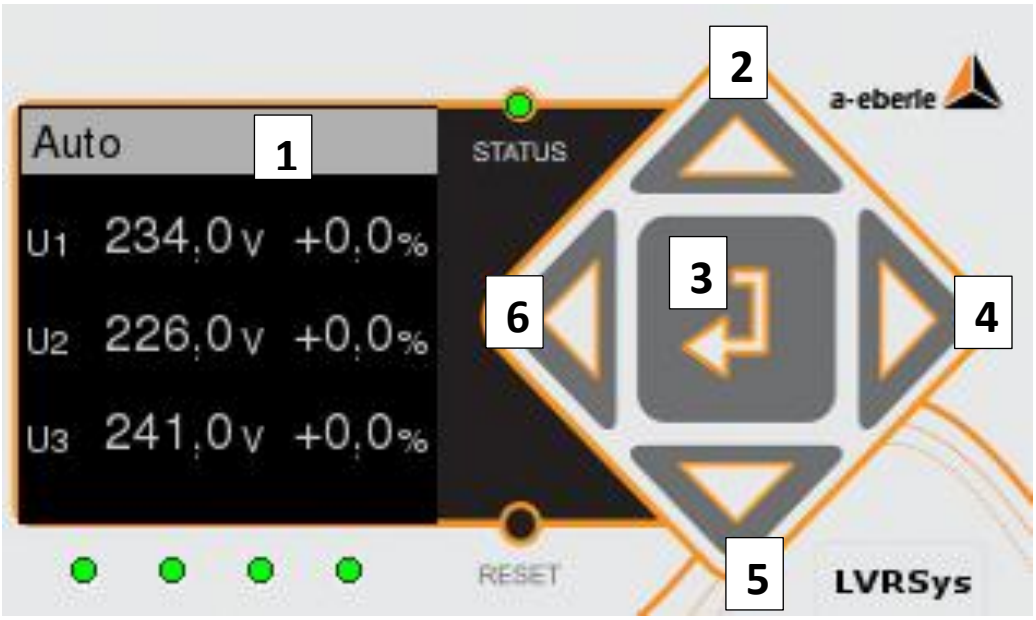


Figure 9-2 Regulator display

1	Mode
2	Browse *up* (only in the user menu or active manual mode)
3	*Enter key* (confirm)
4	Browse *right*
5	Browse *down* (only in the user menu or active manual mode)
6	Browse *left*

9.5 Automatic mode

The regulator is active in *Automatic* mode. After the boot process (connecting the supply voltage) has finished, the regulator switches into *Automatic* mode.

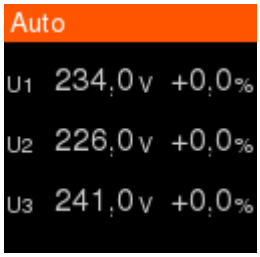


Figure 9-3 Automatic mode

The display shows:

- three phase voltages
- the phases' current tap position

9.6 Blocked mode

The regulator is *blocked* in blocked mode. Only the Enter key can be activated.

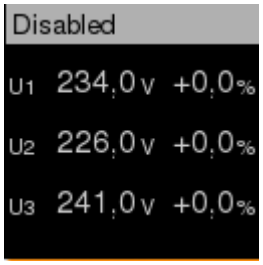


Figure 9-4 Blocked mode display

9.7 Manual mode

The regulator is not active in *Manual* mode. A tap change per second is possible. The bars on the graphic time scale turn red in the event of deviations.

Changing taps manually:

- Select *Manual* mode, press *Enter* in *Automatic* mode. (See Sec. 9.8 Overview of the displays).
- To switch to a lower tap, press the *down* key.
- To switch to a high tap, press the *up* key.

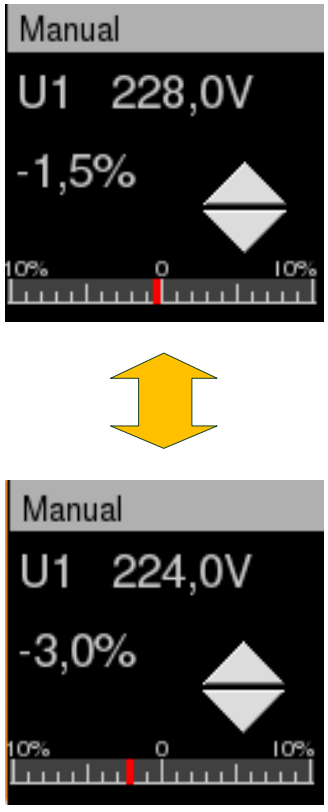


Figure 9-5 Manual mode display

The display shows:

- Mode
- Phase
- Current tap position
- Voltage value
- Deviation from setpoint in %.

9.8 Overview of the displays

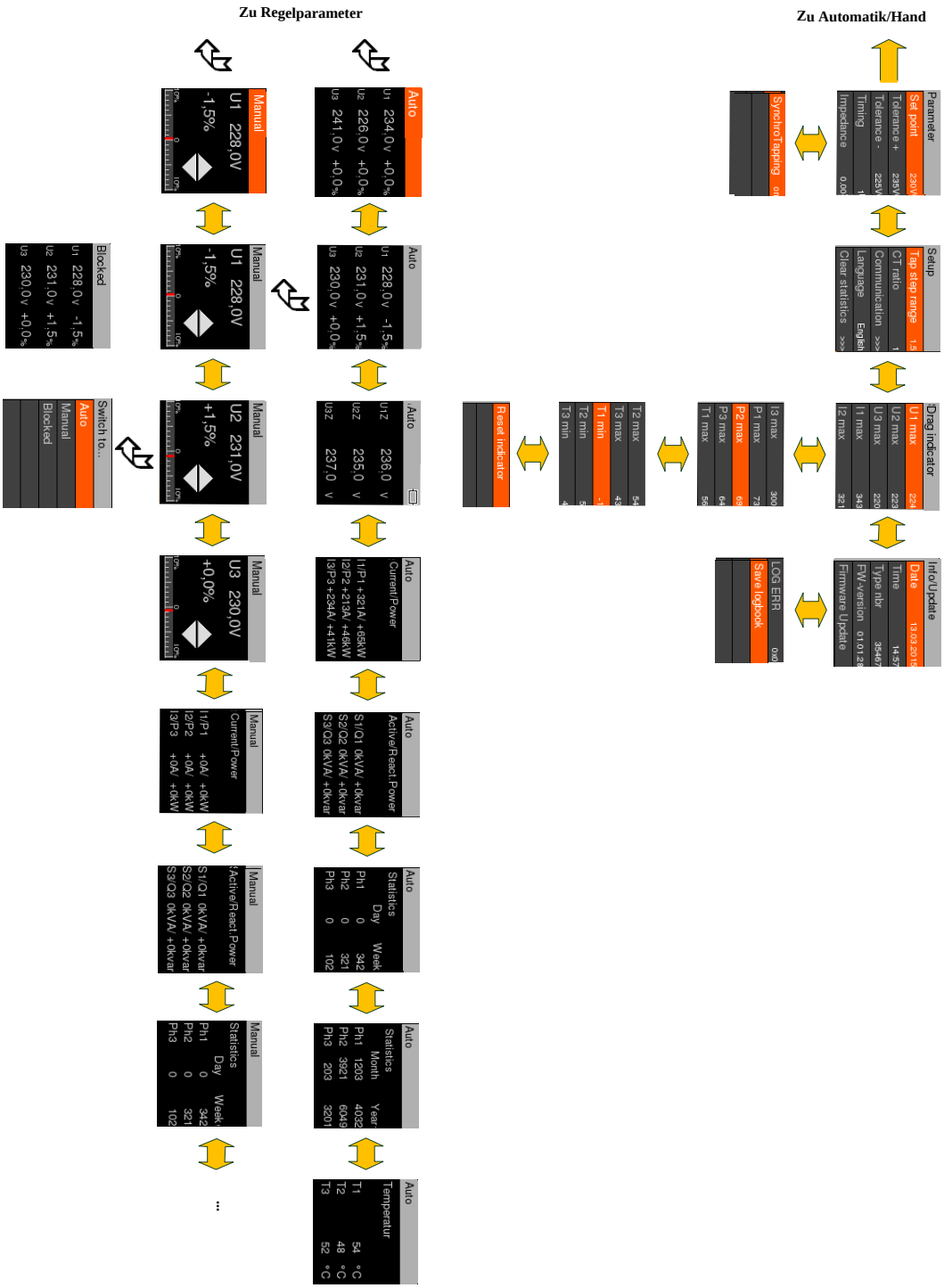


Figure 9-6 Overview of the menu navigation

9.9 Parameters

Each of the parameters are described below.

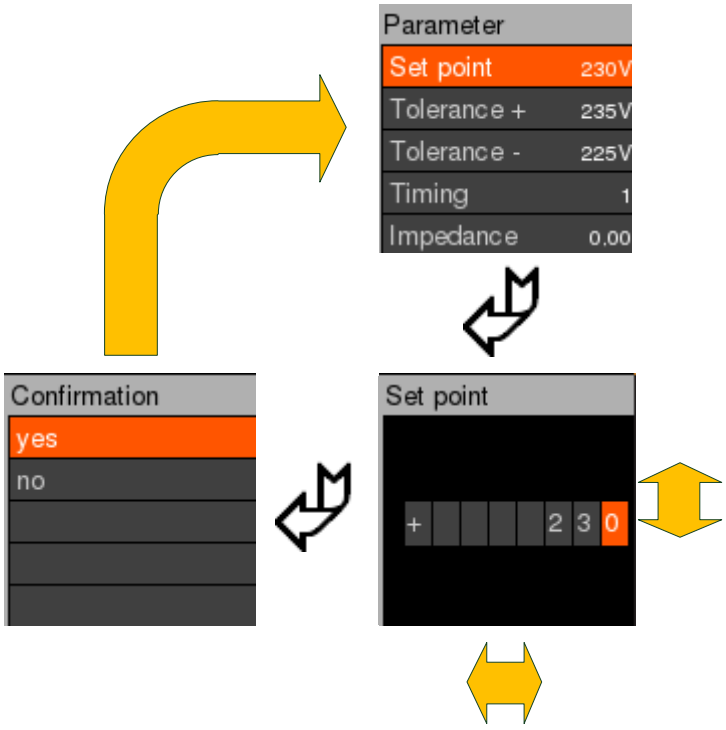


Figure 9-7 Configuring the regulator

- Select the *Parameter* menu (see Sec. 9.8 Overview of the displays).
- To select submenu items, press the *up* or *down* key.
- Press the *Enter key*.

Configuration:

- The parameters are set by pressing the *up*/*down* and *left*/*right* keys.
- Press *Enter* to confirm the selection.

9.9.1 Set point

The default is 230 V.

➲ Set the set point.

9.9.2 Tolerance band+ and tolerance band-

The defaults are:

- 225 V for tolerance band– (*Tolband neg*)
- 235 V for tolerance band+ (*Tolband pos*)

➲ Set the tolerance bands.

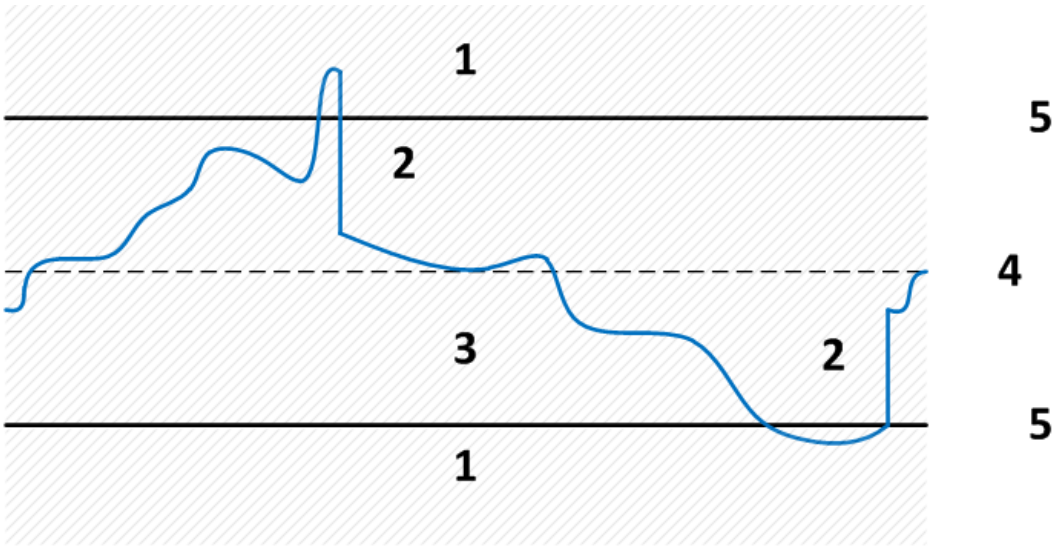


Figure 9-8 Tolerance band zone

1	Regulator active
2	Phasing process
3	Regulator inactive
4	Set point
5	Tolerance bands (tolerance band-/and tolerance band+)

The regulator is inactive if the area between the tolerance bands is under voltage. When the tolerance bands are exceeded, the regulator is activated and as such it will switch the phases according to the parameter settings.

9.9.3 Time delay

The default is 1.

➲ Set time delay to steps of 0.1.

The settable value (time delay) ranges from 0 to 10. Where 10 is the maximum sensitivity.

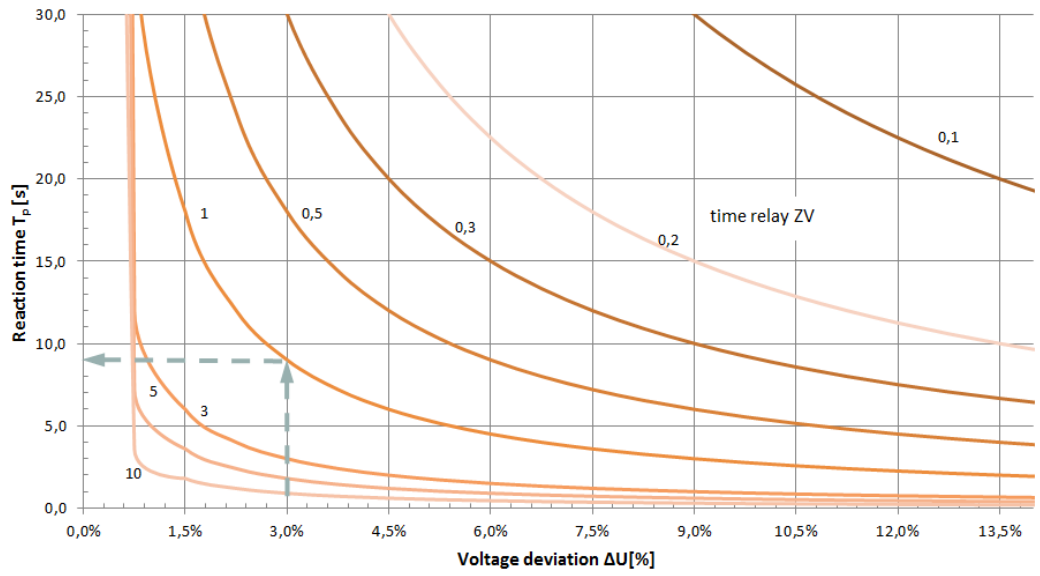


Figure 9-9 Response time in connection with phase spacing 1.5%

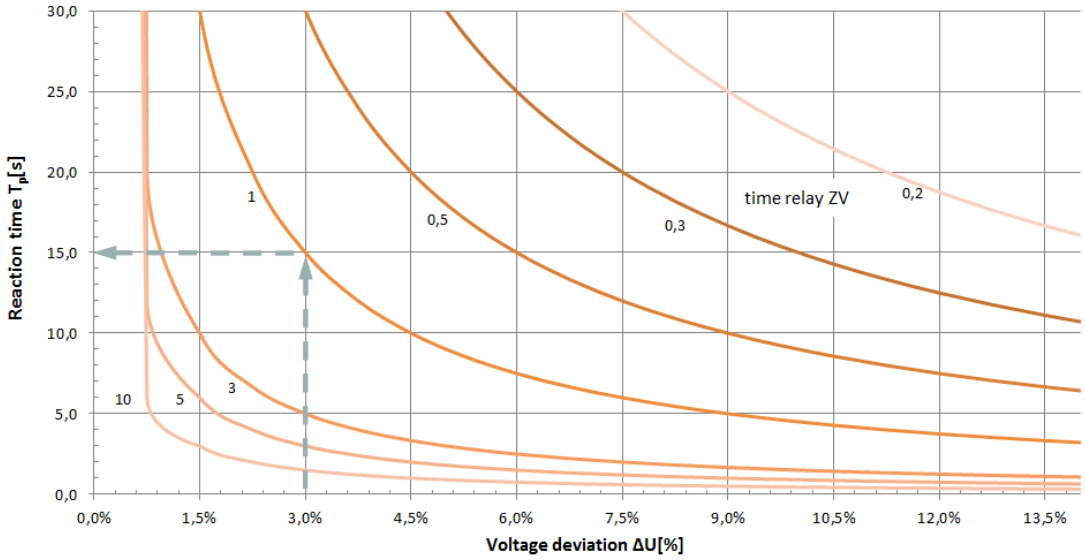


Figure 9-10 Response time in connection with phase spacing 2.5%

Example: For time delay 1 and voltage deviation 3%:

- Phase spacing 1.5% equals response time 9 s.
- Phase spacing 2.5% equals response time 15 s.

9.9.4 Grid impedance

The *Grid impedance* function can only be used if the *Current measurement* option is integrated (Sec. 2.2 Options).

The default is 0 Ω. Impedance is deactivated.

When impedance is deactivated:

- Current-dependent regulation is deactivated.

When impedance is activated:

- Current values are included in regulation.
- Resistance symbol displays in the status window.

➲ Set impedance to 0.01 Ω steps.

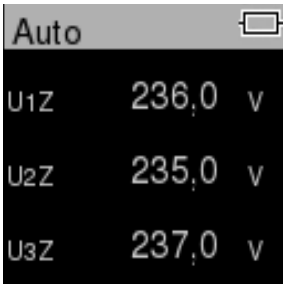


Figure 9-11 active Impedance display

The configuration of the grid impedance takes the load current in the regulator algorithm into account.

Example:

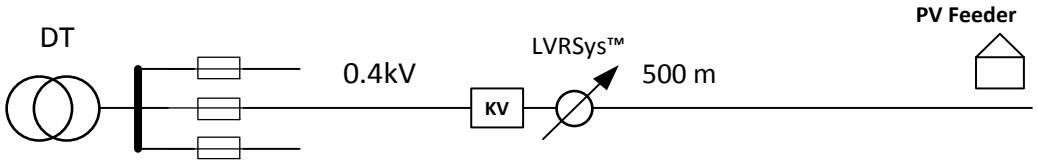


Figure 9-12 Example network branch with a 500 m cable section

Cable	NA2X2Y 4 x 150 mm²
Cable length	500 m
Cable resistance	0.5 km x 0.206 Ω/km = 0.1 Ω

Table 9-1 Cable data

In the example, the voltage value at the end of the cable would deviate from the regulator's voltage value by 100 A x 0.1 Ω = 10 V at a current flow of 100 A.

When configuring the *grid impedance*, the regulator constantly calculates the voltage from the voltage value in the regulator + grid impedance x grid current.

$$U_{Imp} = U_{Regulator} + Z_{Grid} * I_{Grid}$$

9.9.5 Synchro phasing

Synchro phasing is deactivated by default.

➲ Activating or deactivating synchro phasing

A. Eberle GmbH & Co. KG. recommends activating synchro phasing in systems with bus bars, and deactivating it in systems with strand synchro phasing.

9.10 Setup

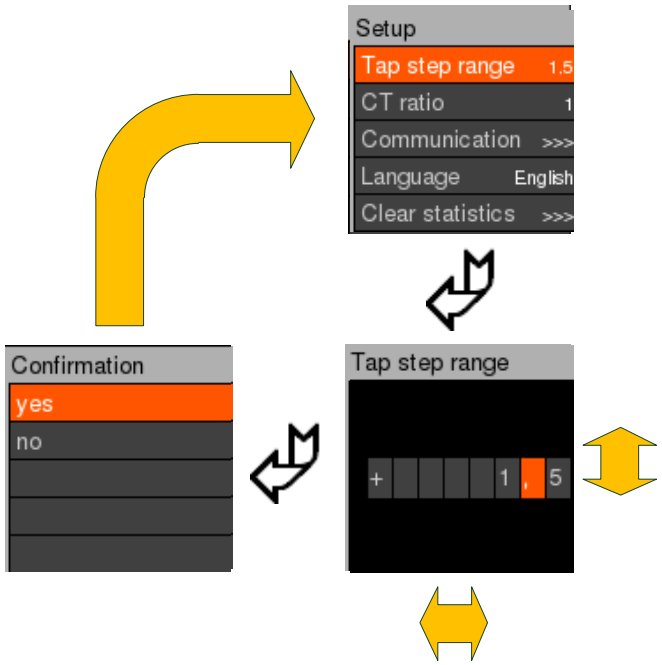


Figure 9-13 Setup

➲ Select the Setup menu (see Sec. 9.8 Overview of the displays).

➲ To select submenu items, press the *up* or *down* key.

➲ Press the *Enter key*.

Configuration:

➲ The parameters are set by pressing the *up*/*down* and *left*/*right* keys.

➲ Press *Enter* to confirm the selection.

9.10.1 Phase spacing

Phase spacing is set at the factory.

↳ Do not change the phase spacing.

9.10.2 KNI (current transformer factor)

For A. Eberle GmbH & Co. KG. current transformers, the transfer ratio is set at the factory.

When external current transformers are used:

➲ Enter the conversion ratio.

9.10.3 Communication

➲ Select the submenu *Communication* to configure the parameters for the communication interfaces.

Available communication interfaces:

- Ethernet
- RS232
- RS485

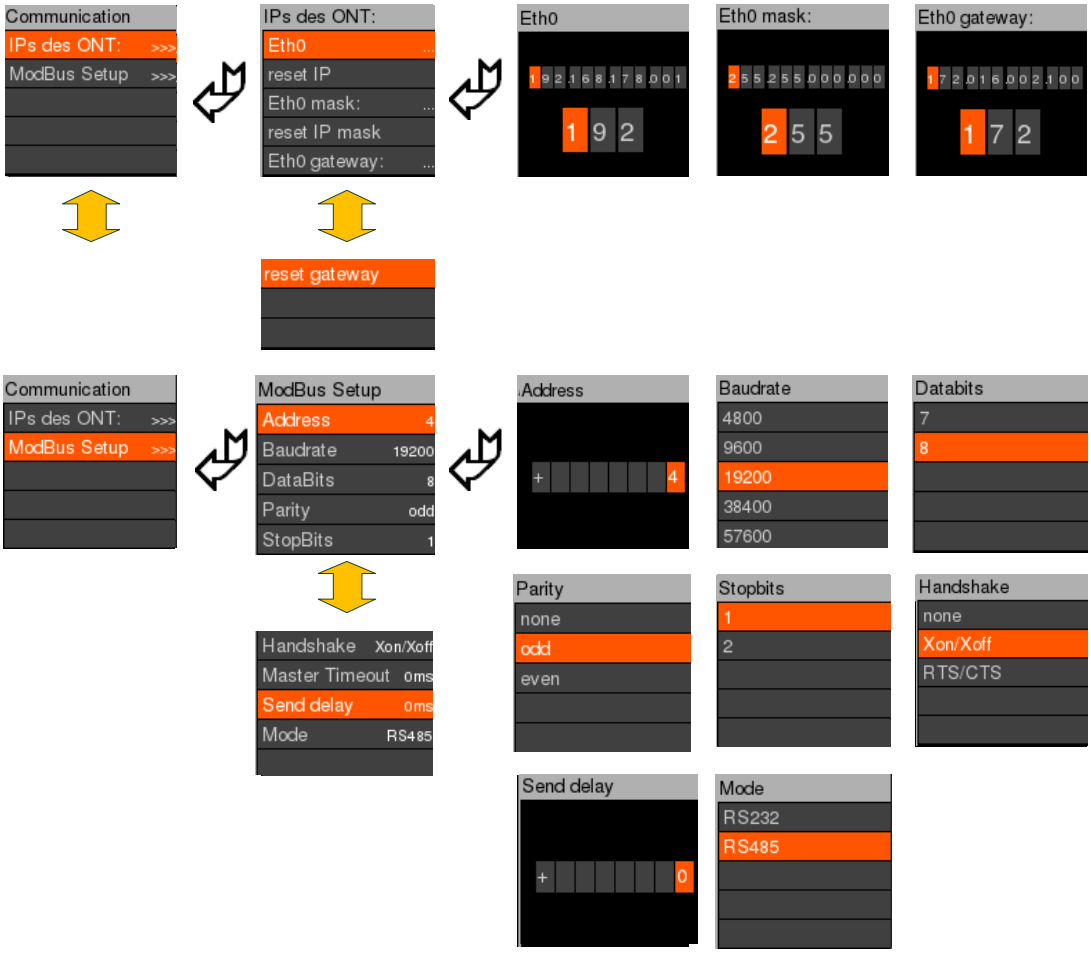


Figure 9-14 Overview of the communication settings

➲ To select submenu items, press the *up* or *down* key.

➲ Press the *Enter key*.

Configuration:

➲ The parameters are set by pressing the *up*/*down* and *left*/*right* keys.

➲ Press *Enter* to confirm the selection.

Standard parameters for the Modbus Communication are:

- Address 4
- Baud rate 19200
- Data bits 8
- Parity odd
- Stop bits 1
- Handshake Xon/Xoff
- Transmission delay 0
- RS232 mode.

9.10.4 Language

Possible languages:

- German
- English

9.10.5 Delete statistics

Delete individual statistics:

➲ Select.

➲ Confirm selection.

↳ Selected statistic is deleted.

9.11 Flyback hand

Flyback hand contains 15 min average values for the:

- maximum voltages (Ph 1-3)
- maximum currents (Ph 1-3)
- maximum output values
- maximum and minimum temperatures in switch cabinet (T 1-3).

  - T1: Temperature of the power stage in °C
  - T2: Temperature of the transformers in °C
  - T3: Temperature of the air in the switch cabinet in °C.

Values can be reset individually.
Resetting the current values also resets the output values.

9.12 Info/Update

The menu item *Info/Update* contains:

- Time
- Date
- Firmware version
- Logbook error entries
- Run Firmware update
- Store logbook event.

9.12.1 Firmware update

⚠ CAUTION!	**Destruction of components due to overload!**
	➲ Make sure the service switch is active before starting the update process.

Activating the service switch isolates the thyristors from the mains voltage and short-circuits the transformers. The control function is out of order. A secure update process can be started.

Update file

➲ Unzip the zip file (from email of download).

➲ Save the files on a *FAT32* formatted USB stick (the folder structure below is mandatory).

Name	Type	Compressed size	Password ...	Size	Ratio	Date modified
app	File folder					
images	File folder					
script	File folder					
update	File folder					
winupdate	Configuration settings	1 KB	No	1 KB	46%	25.02.2015 14:15

Figure 9-15 Folder structure for the update on USB stick

Full update procedure:

➲ Activate the service switch. (See Sec. 9.2.2 Switch).

↳ Regulator goes into error mode.

➲ Insert USB stick.

➲ Select menu item *Firmware update*.

➲ Press *Yes* to confirm the selection.

↳ *Please wait* displays.

➲ Do not press any buttons or activate the service switch during the update process.

↳ Regulator needs about 5 minutes for the update process to complete.
↳ The regulator reinitializes.
↳ The regulator stays in error mode when the update is completed.

➲ Deactivate the service switch.

➲ Remove the USB stick.

↳ Regulator goes into *automatic* mode.
↳ The update procedure is finished.

9.12.2 LOG ERR

The last error is displayed.

➲ Note the error is the installation is malfunctioning.

➲ Contact the A. Eberle GmbH & Co. KG. Support team.

Error code table

Transformer	0x001
Contactor	0x002
Overvoltage	0x004
Under voltage	0x008
Over temperature Channel 1	0x010
Over temperature Channel 2	0x020
Over temperature Channel 3	0x040
EEPROM	0x080
SPI	0x100
Input voltage	0x200
Frequency	0x400
Service switch	0x800

Table 9-2 Error code table

9.12.3 Archive log book

➲ Insert USB stick.

➲ Select menu item *Logbook*.

➲ Select submenu item *Start time*.

Data are archived from the start time.

The data *Event data, measurement data, service data* must be activated in order to archive them.

- ( ) Selection inactive
- (x) Selection active

➲ Select the submenu item *Event data, measurement data and service data*.

➲ Select with the *up* or *down* key.

➲ Press *Yes* to confirm the selection.

➲ Select the submenu item *Archive data*.

➲ Press *Yes* to confirm the selection.

↳ *Please wait* displays.

↳ Regulator writes data to the USB stick.

Event data contain:

- Parameters
- Reparameterization
- State (*Automatic/Manual/Blocked*)
- State changes (*Automatic-Manual*)
- Error.

Measurement data

Measurement data contain:

- U1 to U3 (10 minutes average values in V)
- I1 to I3 (10 minutes average values in A; only for option *Current transformer*)
- P1 to P3 (10 minutes average values in kW; only for option *Current transformer*)
- Q1 to Q3 (10 minutes average values in kvar; only for option *Current transformer*)
- S1 to S3 (10 minutes average values in kVA; only for option *Current transformer*)
- T1 to T3 (10 minutes average values in °C)
- Tap 1 to Tap 3 (current tap position Ph1-Ph3 at the time)
- Taps/Period 1-3 (10 minutes average values of tap position Ph1-Ph3).

Service data

Service data are intended solely for the A. Eberle GmbH & Co. KG. support team to perform evaluations.

9.12.4 Evaluate logbook (*Measurement data*) with Microsoft Excel

(other spreadsheet software can also be used).

➲ Open the *Measurement data* in Excel.

➲ Select the first column (A).

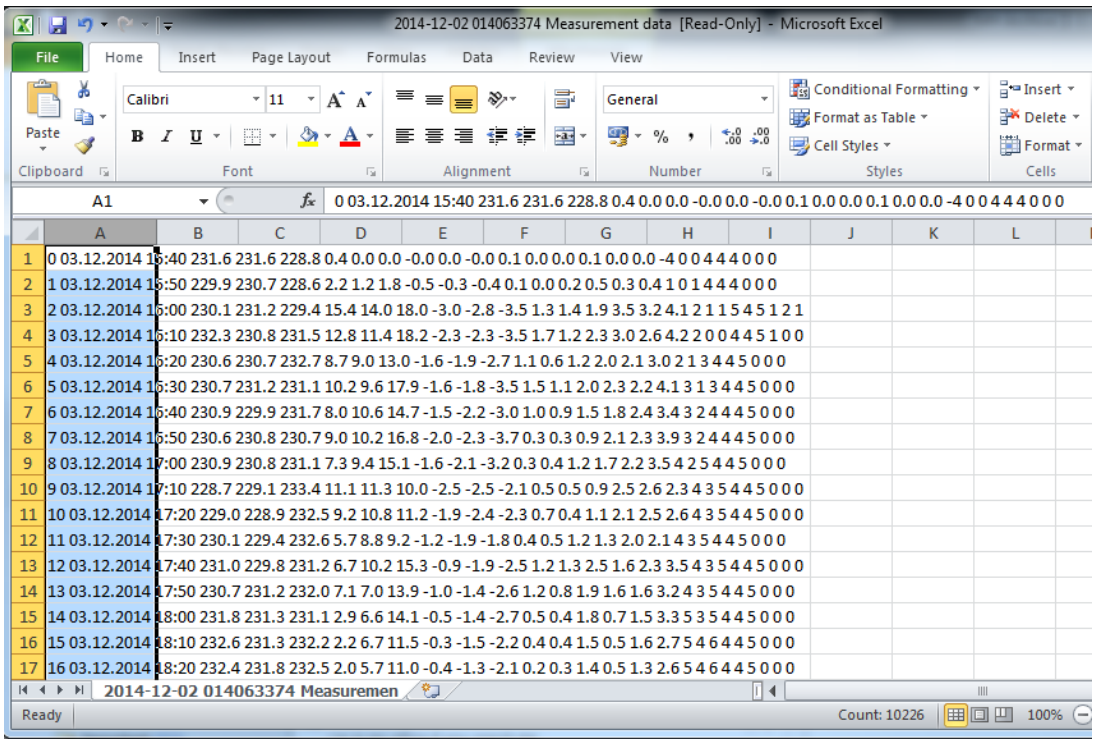


Figure 9-16 Selecting the first column

➲ Under *Data*, press *Text to Columns*.

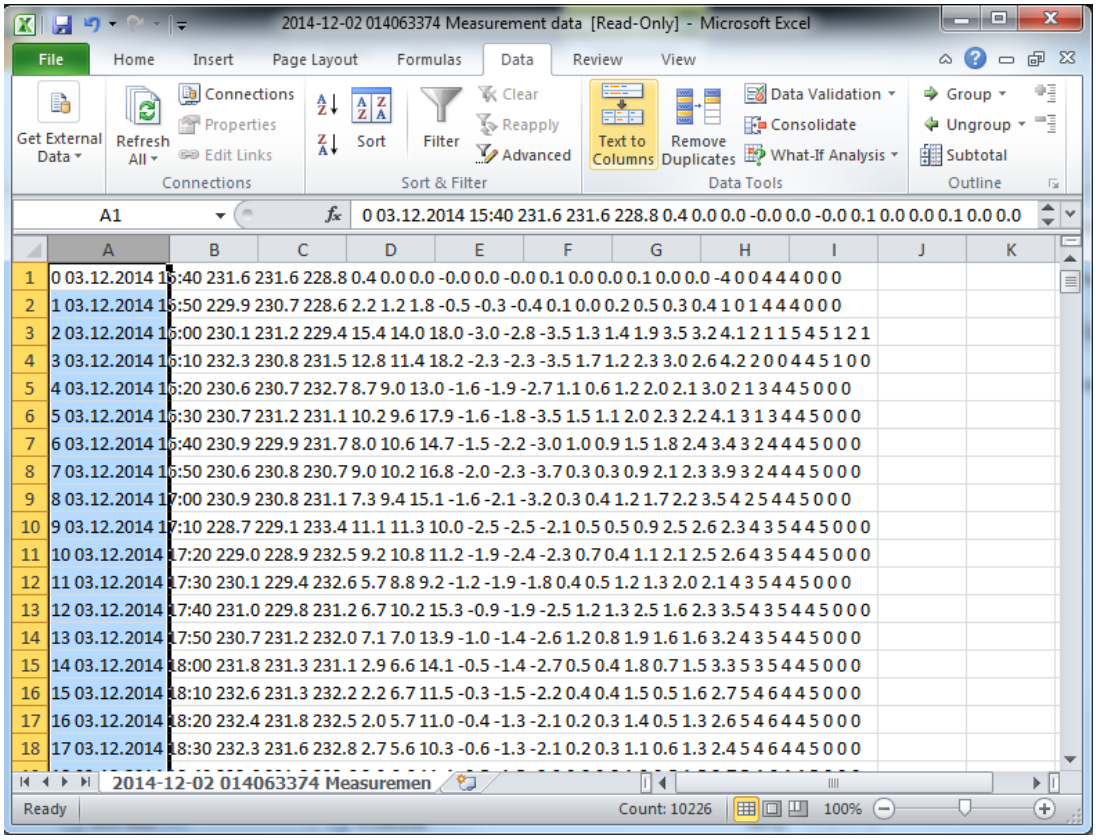


Figure 9-17 Selecting data and text in columns

- Convert Text to Columns Wizard - Step 1 of 3 select *Delimited.*
- Press *Next* to confirm

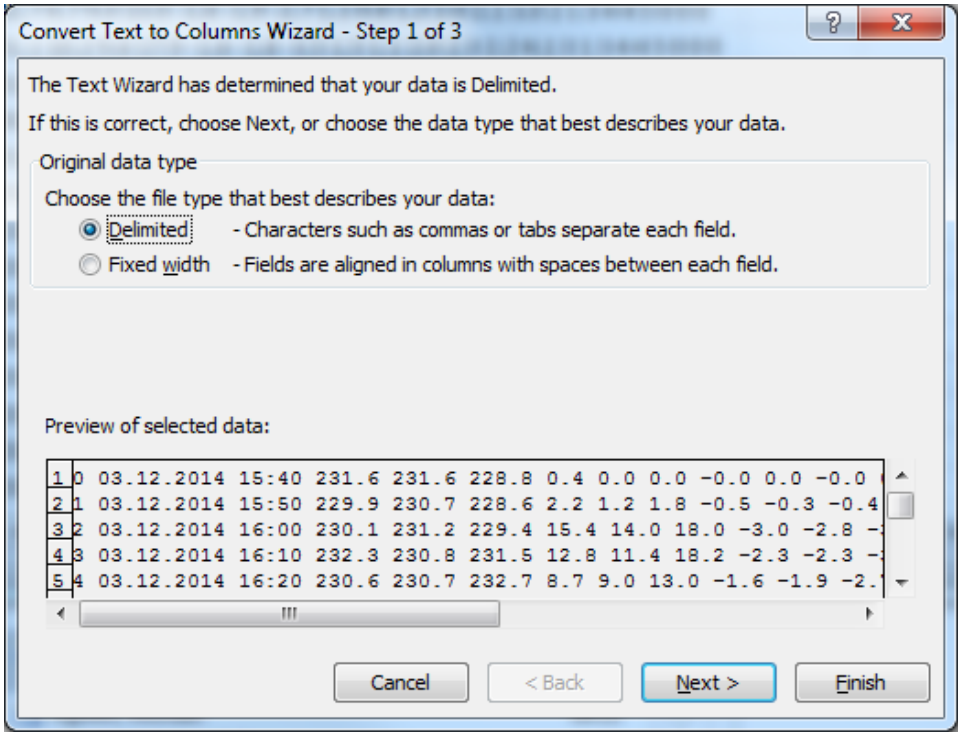

Convert Text to Columns Wizard - Step 1 of 3
The Text Wizard has determined that your data is Delimited.
If this is correct, choose Next, or choose the data type that best describes your data.
Original data type
Choose the file type that best describes your data:
Delimited - Characters such as commas or tabs separate each field.
Fixed width - Fields are aligned in columns with spaces between each field.
Preview of selected data:
1 0 03.12.2014 15:40 231.6 231.6 228.8 0.4 0.0 0.0 -0.0 0.0 -0.0
2 1 03.12.2014 15:50 229.9 230.7 228.6 2.2 1.2 1.8 -0.5 -0.3 -0.4
3 2 03.12.2014 16:00 230.1 231.2 229.4 15.4 14.0 18.0 -3.0 -2.8
4 3 03.12.2014 16:10 232.3 230.8 231.5 12.8 11.4 18.2 -2.3 -2.3
5 4 03.12.2014 16:20 230.6 230.7 232.7 8.7 9.0 13.0 -1.6 -1.9
Cancel
< Back
Next >
Finish

Figure 9-18 Text conversion wizard - Step 1 of 3

- Convert Text to Columns Wizard - Step 2 of 3 select *Space.*
- Press *Next* to confirm

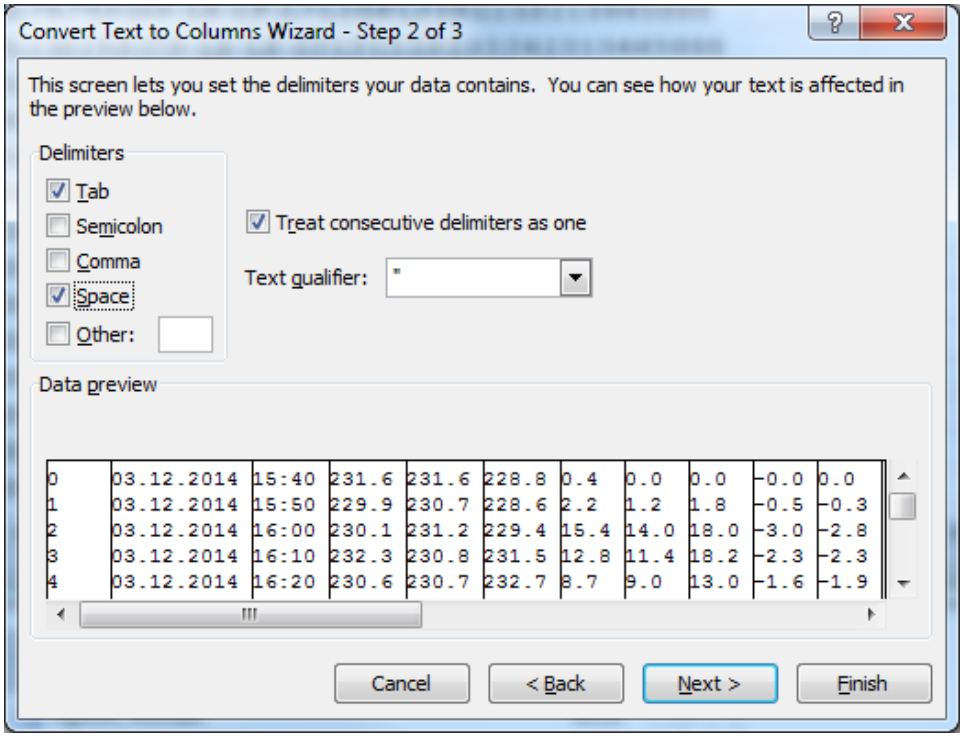

Convert Text to Columns Wizard - Step 2 of 3
This screen lets you set the delimiters your data contains. You can see how your text is affected in the preview below.
Delimiters
Tab
Semicolon
Comma
Space
Other:
Treat consecutive delimiters as one
Text qualifier:
Data preview
0 03.12.2014 15:40 231.6 231.6 228.8 0.4 0.0 0.0 -0.0 0.0
1 03.12.2014 15:50 229.9 230.7 228.6 2.2 1.2 1.8 -0.5 -0.3
2 03.12.2014 16:00 230.1 231.2 229.4 15.4 14.0 18.0 -3.0 -2.8
3 03.12.2014 16:10 232.3 230.8 231.5 12.8 11.4 18.2 -2.3 -2.3
4 03.12.2014 16:20 230.6 230.7 232.7 8.7 9.0 13.0 -1.6 -1.9
Cancel
< Back
Next >
Finish

Figure 9-19 Text conversion wizard - Step 2 of 3

- Convert Text to Columns Wizard - Step 3 of 3 presses on *Advanced...*

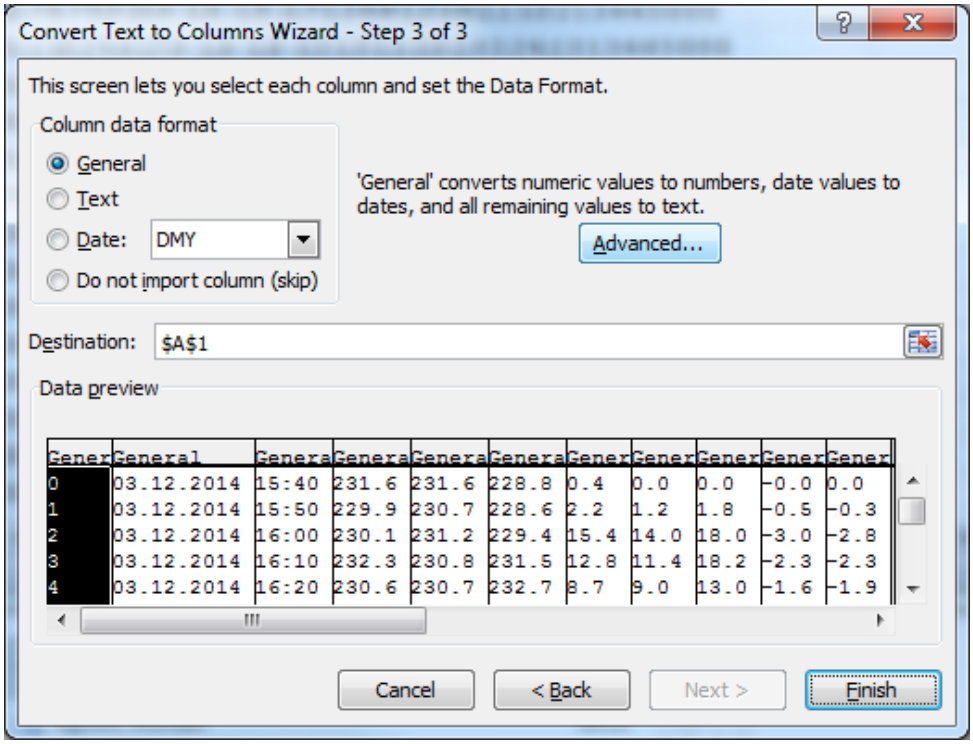

Convert Text to Columns Wizard - Step 3 of 3
This screen lets you select each column and set the Data Format.
Column data format
General
Text
Date: DMY
Do not import column (skip)
'General' converts numeric values to numbers, date values to dates, and all remaining values to text.
Advanced...
Destination: A1
Data preview
Gener General Genera Genera Genera Genera Gener Gener Gener Gener Gener
0 03.12.2014 15:40 231.6 231.6 228.8 0.4 0.0 0.0 -0.0 0.0
1 03.12.2014 15:50 229.9 230.7 228.6 2.2 1.2 1.8 -0.5 -0.3
2 03.12.2014 16:00 230.1 231.2 229.4 15.4 14.0 18.0 -3.0 -2.8
3 03.12.2014 16:10 232.3 230.8 231.5 12.8 11.4 18.2 -2.3 -2.3
4 03.12.2014 16:20 230.6 230.7 232.7 8.7 9.0 13.0 -1.6 -1.9
Cancel
< Back
Next >
Finish

Figure 9-20 Text conversion wizard - Step 3 of 3

- Decimal separator: Select *Point.*
- Press *OK* to confirm
- Press *Finish* in the Convert Text to Columns Wizard to confirm.

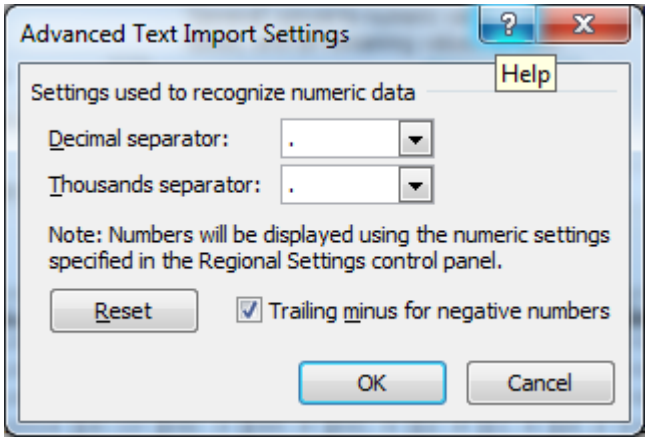


Figure 9-21 Other text import settings

- Splitting measurement data across columns.

9.12.5 Evaluate logbook (*Event data*) in Notepad++

(other text processing software can also be used).

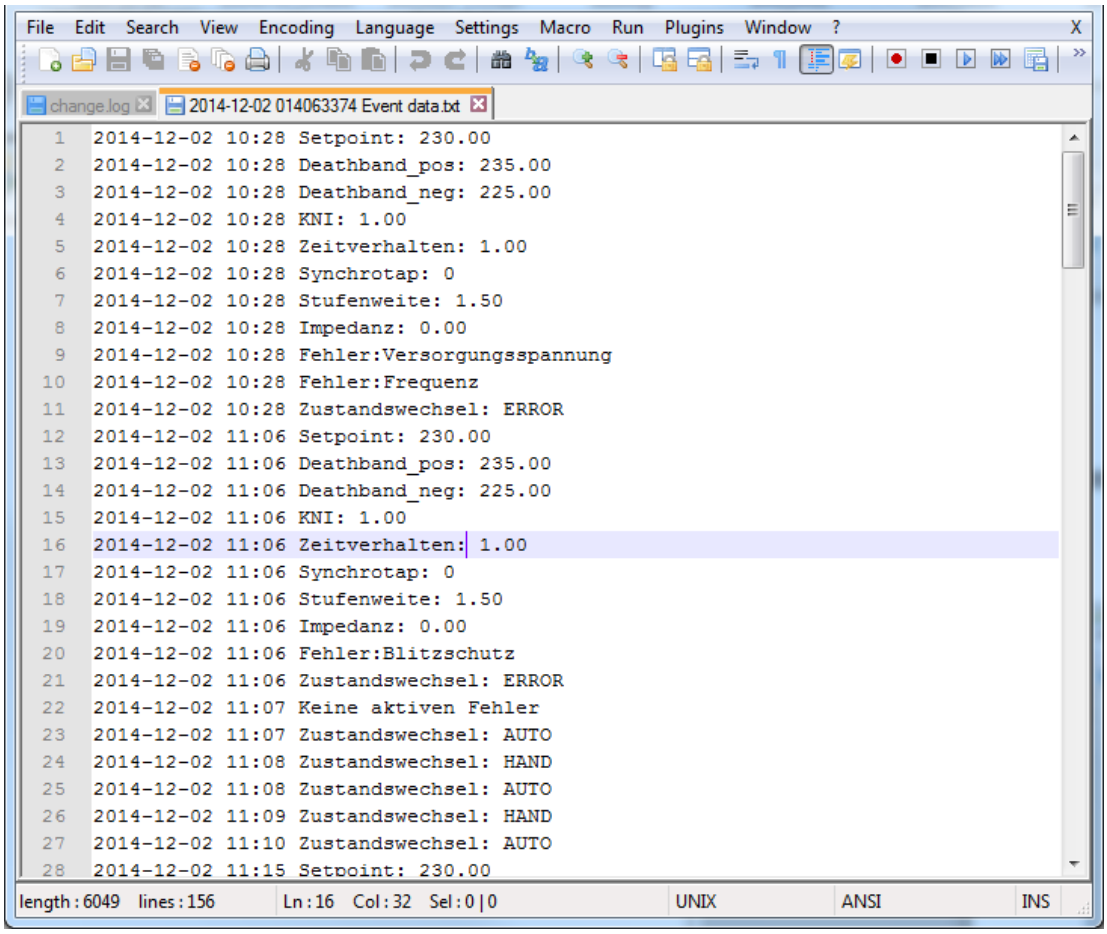

File Edit Search View Encoding Language Settings Macro Run Plugins Window ? X
change.log
2014-12-02 014063374 Event data.txt
1 2014-12-02 10:28 Setpoint: 230.00
2 2014-12-02 10:28 Deathband_pos: 235.00
3 2014-12-02 10:28 Deathband_neg: 225.00
4 2014-12-02 10:28 KNI: 1.00
5 2014-12-02 10:28 Zeitverhalten: 1.00
6 2014-12-02 10:28 Synchrotap: 0
7 2014-12-02 10:28 Stufenweite: 1.50
8 2014-12-02 10:28 Impedanz: 0.00
9 2014-12-02 10:28 Fehler:Versorgungsspannung
10 2014-12-02 10:28 Fehler:Frequenz
11 2014-12-02 10:28 Zustandswechsel: ERROR
12 2014-12-02 11:06 Setpoint: 230.00
13 2014-12-02 11:06 Deathband_pos: 235.00
14 2014-12-02 11:06 Deathband_neg: 225.00
15 2014-12-02 11:06 KNI: 1.00
16 2014-12-02 11:06 Zeitverhalten: 1.00
17 2014-12-02 11:06 Synchrotap: 0
18 2014-12-02 11:06 Stufenweite: 1.50
19 2014-12-02 11:06 Impedanz: 0.00
20 2014-12-02 11:06 Fehler:Blitzschutz
21 2014-12-02 11:06 Zustandswechsel: ERROR
22 2014-12-02 11:07 Keine aktiven Fehler
23 2014-12-02 11:07 Zustandswechsel: AUTO
24 2014-12-02 11:08 Zustandswechsel: HAND
25 2014-12-02 11:08 Zustandswechsel: AUTO
26 2014-12-02 11:09 Zustandswechsel: HAND
27 2014-12-02 11:10 Zustandswechsel: AUTO
28 2014-12-02 11:15 Setpoint: 230.00
length : 6049 lines : 156
Ln : 16 Col : 32 Sel : 0 | 0
UNIX
ANSI
INS

Figure 9-22 Event data opened in Notepad++

9.13 Communication

9.13.1 Modbus

Modbus enables the LVRSys™ to be connected to a control system for communication.

Possible Modbus interfaces:

- RS 232
- RS 485
- TCP

Register mapping

Input register (16-Bit data, read only)			
Name	permitted values	Standard	Addressing
Status	2 - Operation, 1 - Error	2	101

Table 9-3 Status

Holding registers (16-Bit data, read and write)			
Name	permitted values	Standard	Addressing
Operating status	0 - *Auto*, 1 - *Manual*, 2 - *Blocked*	0	201
Ph1 Step up	0/1 1 - Command *Step up*	0	202
Ph2 Step up	0/1 1 - Command *Step up*	0	203
Ph3 Step up	0/1 1 - Command *Step up*	0	204
Ph1 Step up	0/1 1 - Command *Step down*	0	205
Ph2 Step down	0/1 1 - Command *Step down*	0	206
Ph3 Step down	0/1 1 - Command *Step down*	0	207
Delete statistics	0/1 1 - Command *Delete statistics*	0	208
Reset Flyback hand	0/1 1 - Command *Reset Flyback hand*	0	209

Table 9-4 Operating status and regulator commands

Input register (16-Bit data, read only)			
Name	permitted values	Unit	Addressing
Phase spacing	0 - 1000	0.01	301
Step phase 1	0 - 8	1	302
Step phase 2	0 - 8	1	303
Step phase 3	0 - 8	1	304
Voltage phase 1	0 - 65000	0.1 V	305
Voltage phase 2	0 - 65000	0.1 V	306
Voltage phase 3	0 - 65000	0.1 V	307

Input register (16-Bit data, read only)			
Name	permitted values	Unit	Addressing
Current phase 1	0 - 65000	0.1 A	308
Current phase 2	0 - 65000	0.1 A	309
Current phase 3	0 - 65000	0.1 A	310
Active power phase 1	-32500 - 0 - 32500	0.1 kW	311
Active power phase 2	-32500 - 0 - 32500	0.1 kW	312
Active power phase 3	-32500 - 0 - 32500	0.1 kW	313
Apparent power phase 1	0 - 65000	0.1 kVA	314
Apparent power phase 2	0 - 65000	0.1 kVA	315
Apparent power phase 3	0 - 65000	0.1 kVA	316
Reactive power phase 1	-32500 - 0 - 32500	0.1 kVar	317
Reactive power phase 2	-32500 - 0 - 32500	0.1 kVar	318
Reactive power phase 3	-32500 - 0 - 32500	0.1 kVar	319
Step number Day Ph1	0 - 99999999	1	320
Step number Day Ph2	0 - 99999999	1	321
Step number Day Ph3	0 - 99999999	1	322
Step number Week Ph1	0 - 99999999	1	323
Step number Week Ph2	0 - 99999999	1	324
Step number Week Ph3	0 - 99999999	1	325
Step number Month Ph1	0 - 99999999	1	326
Step number Month Ph2	0 - 99999999	1	327
Step number Month Ph3	0 - 99999999	1	328
Step number Year Ph1	0 - 99999999	1	329
Step number Year Ph2	0 - 99999999	1	330
Step number Year Ph3	0 - 99999999	1	331
Temperature Controls	0 - 65000	0.1°C	332
Temperature Power stage	0 - 65000	0.1°C	333
Temperature Switch cabinet	0 - 65000	0.1°C	334
Flyback hand U1 max.	0 - 65000	0.1 V	335
Flyback hand U2 max.	0 - 65000	0.1 V	336
Flyback hand U3 max.	0 - 65000	0.1 V	337
Flyback hand I1 max.	0 - 65000	0.1 A	338
Flyback hand I2 max.	0 - 65000	0.1 A	339
Flyback hand I3 max.	0 - 65000	0.1 A	340
Flyback hand P1 max.	0 - 65000	0.1 kW	341
Flyback hand P2 max.	0 - 65000	0.1 kW	342

Input register (16-Bit data, read only)			
Name	permitted values	Unit	Addressing
Flyback hand P3 max.	0 - 65000	0.1 kW	343
Flyback hand T1 max.	0 - 65000	0.1°C	344
Flyback hand T2 max.	0 - 65000	0.1°C	345
Flyback hand T3 max.	0 - 65000	0.1°C	346
Flyback hand T1 max.	0 - 65000	0.1°C	347
Flyback hand T2 max.	0 - 65000	0.1°C	348
Flyback hand T3 max.	0 - 65000	0.1°C	349
Firmware	0 - 65000	1	350
LOG-ERR	0 - 65000	1	351

Table 9-5 Measurement and informational value register

Holding registers (16-Bit data, read and write)				
Name	permitted values	Standard	Unit	Addressing
Mode	0 - RS232; 1 - RS485	0	1	401
Baud rate	12, 24, 48, 96, 192, 384, 768, 1152	192	100 Bit/s	402
Parity	0 (none), 1 (odd), 2 (even)	2	---	403
Address	1..247, 255 according to production	255	1	404
Set point	0 - 65000	23000	0.01 V	405
Tolerance band+	0 - 65000	23500	0.01 V	406
Tolerance bands-	0 - 65000	22500	0.01 V	407
Time delay	0 - 1000	100	0.01	408
Synchro phasing	0 - asym. 1 - sym.	0	1	409
Grid impedance	0 - 500	0	0.001 Ω	410

Table 9-6 Parameter register

9.13.2 Additional log files

➲ Ask A. Eberle GmbH & Co. KG. about the implementation of additional communication log files.

10. Controls and Power stage

10.1 Controls

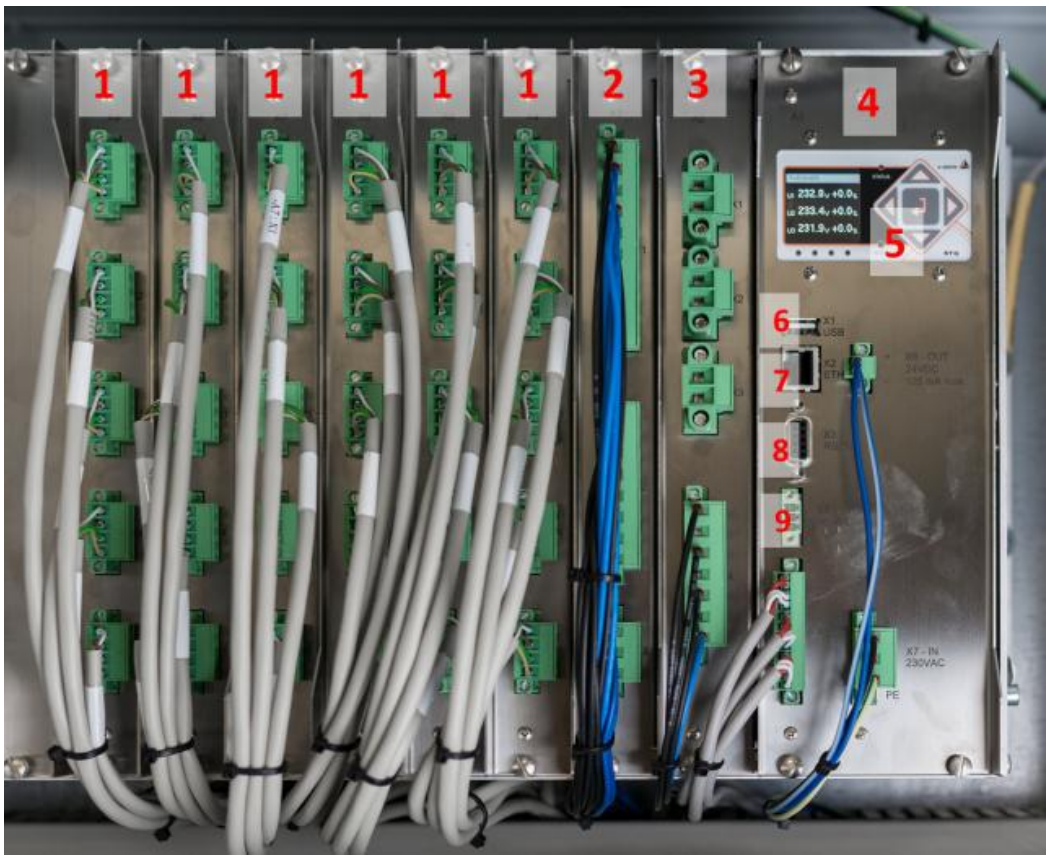


Figure 10-1 Controls overview

1	Thyristor driver board
2	Binary input and output circuit board
3	Current and voltage measurement circuit board
4	CPU circuit board
5	Controller display
6	USB interface
7	Ethernet interface
8	RS 232 Interface
9	RS 485 Interface

Table 10-1 Controls description

10.2 Interfaces and log files

10.2.1 USB

USB interface is for firmware update and logbook backup.

Figure 10-2 USB interface

10.2.2 Ethernet

Ethernet interface is for communication interface for Modbus applications.

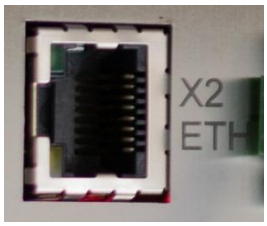


Figure10-3 Ethernet interface

10.2.3 RS 232

RS 232 interface is for communication interface for Modbus applications.

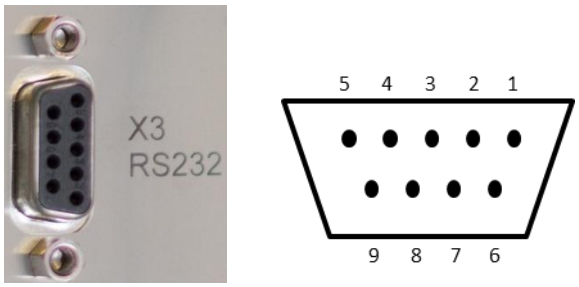


Figure 10-4 RS 232 interface

1	Empty	6	Empty
2	Rx	7	RTS
3	Tx	8	CTS
4	Empty	9	Empty
5	GND		

Table 10-2 Description of the interface

10.2.4 RS 485

RS 485 interface is for communication interface for Modbus applications.

Figure 10-5 RS 485 interface

1	P
2	N
3	GND

Table 10-1 Interface description

10.3 Power stage

DANGER!	**Danger of electric shock!**
	➲ Do not remove protective covers.

The power stage controls the transformers (see Sec. 6 Description and Principle of Operation).

The power stage is behind the aluminium cover with the A. Eberle GmbH & Co. KG. logo.

10.4 Current transformers

DANGER!	**Danger of electric shock!**
	➲ Short circuiting of the current transformers.

The current transformers(see Figure 10-6 Current transformer) are connectet to the control via the current clamps (see Figure 10-7 Current transformer clamps and connectors). The measuring circuit must be only disconnected in *BYPASS* mode (see Sec. 8.2 Taking LVRSys™ out of operation and *BYPASS* mode).

When replacing the control board *3* (see Sec. 10.1 Controls) Current transformer has to be short circuited via the current transformer clamps (see Figure 10-7 middle switch position).

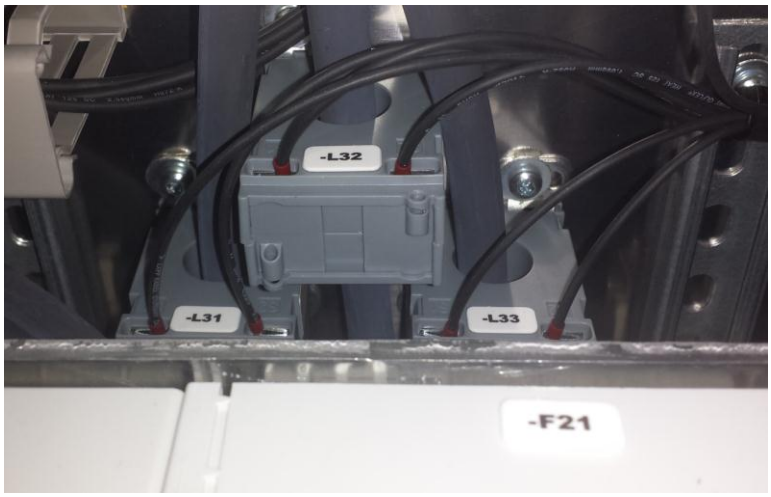


Figure 10-6 Current transformer

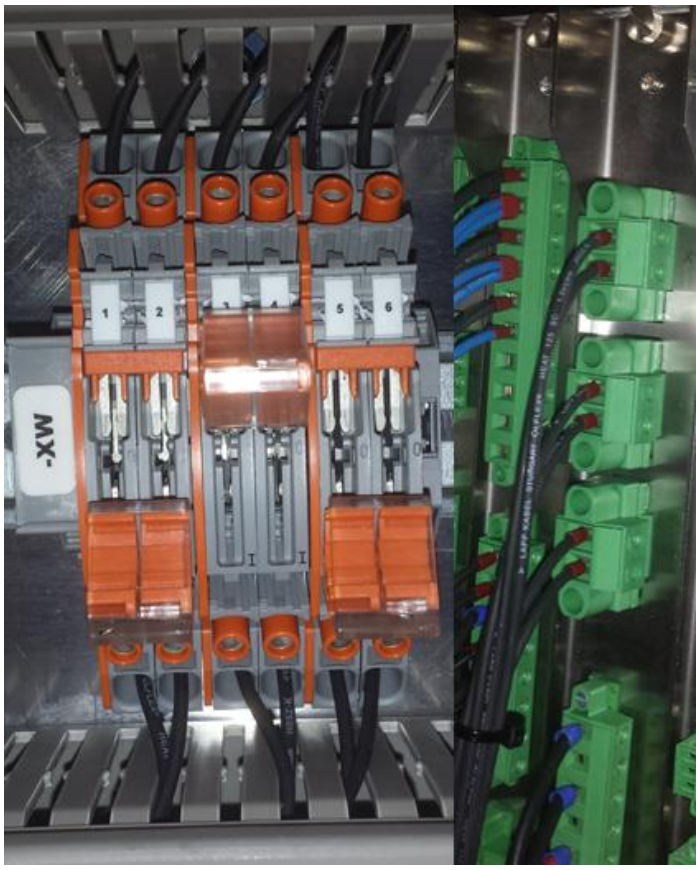


Figure 10-7 Current transformer clamps and connectors

11. External devices and modifications

11.1 External devices

⚠ DANGER!	**Danger of electric shock!**
	➲ External devices must be de-energized before they are connected.

Figure 11-8 Switch cabinet area for external devices

Connecting external devices:

➲ Connecting to the external conductor at LVRSys™ output:

- Use the upper terminals only.
- Two terminals for each phase are available
- 1A (microfuse) standard protection against short circuiting

➲ Connect to neutral conductor:

- Four terminals available

➲ Connect to protective earth:

- Four terminals available

11.2 Modification voltage & current measurement

- When the option Voltage taps at the input of the LVRSys™ is selected, voltage taps are installed on the input side of the busbar system.
- When the option Current measurement/converter at the input of the LVRSys™ is selected, current transformers are installed on the input side of the busbar system.
- When the option Current measurement/converter at the output of the LVRSys™ is selected, current transformers are installed on the output side of the busbar system.

⚠ DANGER!	**Danger of electric shock!**
	➲ Current transformer short circuit.
	➲ Open fuse.

The voltage taps and the current transformers are only free of voltage when fuse is open and current transformer are short circuit.

11.3 Modification

⚠ DANGER!	**Danger of electric shock!**
	➲ Make sure the installation is de-energized before making any modifications.
	➲ For modifications to the bus system, the LVRSys™ must be isolated. (See Sec. 8.2 Taking LVRSys™ out of operation and *BYPASS* mode).

Discuss all modifications with A. Eberle GmbH & Co. KG. first.

11.4 PQI-DA *smart*

- When the option Power quality measurement at LVRSys™ input is selected, voltage taps and current transformer are installed on the input side of the busbar system.
- When the option Power quality measurement at LVRSys™ output is selected, voltage taps and current transformer are installed on the output side of the busbar system.

⚠ DANGER!	**Danger of electric shock!**
	➲ Current transformer short circuit.
	➲ Open fuse.

The PQI-DA *smart* are only free of voltage when fuse is open and current transformer are short circuit.

12. Servicing/Cleaning/Spare parts

- The service interval depends on the operating and environmental conditions.
- Service at least once a year.

12.1 Switch cabinet

Hinges:

➲ Make sure the hinges move freely.

➲ If required, spray with non-aqueous lubricant.

Lock:

➲ Make sure the lock moves freely.

➲ If required, spray moving locking pieces and profile cylinder with non-aqueous lubricant.

Door stay hinge:

➲ Check the door stay hinge.

➲ Replace defective door stay hinge.

➲ If required, spray moving point with non-aqueous lubricant.

Surfaces:

➲ Testing and cleaning the ventilation gills in the rain cover.

➲ Check all components and surfaces for external damage and signs of corrosion.

➲ Remove light white rust.

➲ As protection against white rust, treat the surfaces with a lightly oiled cloth.

➲ Clean the switch cabinet.

Seals:

- Check seals.
- Replace damaged seals in the pressing edges.
- Lubricate seals to prevent freezing (e.g. with talcum, Vaseline, wax).

For small-area damage:

- Sand the damaged area lightly and remove all signs of corrosion and dirt.
- Apply touch-up paint.
- Based on the size of the damage, touch up with:
  - Touch-up applicator
  - Paint brush
  - Spray can of paint.
- Alternatively apply 2K-PUR acrylic paint.
- Observe the manufacturer's processing instructions.

For large-area damage (e.g. from strong abrasion and UV fading):

- Rub the surface evenly and clean with white spirit.
- Paint over the whole area with Rittal touch-up paint (alternatively: 2K-PUR acrylic paint; observe the manufacturer's processing instructions).
- Alternatively apply 2K-PUR acrylic paint.
- Observe the manufacturer's processing instructions.

User the following RAL 7035 colours:

- Touch-up applicator 12ml
- Spray can 150ml
- Paint can 1000ml.

12.2 Power stage

⚠ DANGER!	**Danger of electric shock!**
	➲ Make sure the power stage is de-energized before servicing.

Servicing the power stage:

➲ Press on Thyristor plug contacts.

➲ Check warning signs.

➲ Check contacts. If necessary, tighten (torque under Table 12-1 Power stage components).

Installation	Contact	Torque	Figure
55 kVA 110 kVA 175 kVA 250 kVA ±6%	Thyristor for aluminium plate SKKT 106/18E Thyristor for copper bus SKKT 106/18E	M6 5 Nm ±15% (hexagon socket) M5 3 Nm ±15% (hexagon socket)	
250 kVA ±10% 400 kVA ±6%	Thyristor for aluminium plate SKKT 162/18E Thyristor for copper bus SKKT 162/18E	M6 5 Nm ±15% (hexagon socket) M6 5 Nm ±15% (hexagon socket)	
All installations	Gate plug-in connector (for the controls)	With flat-blade screwdriver ca. 5 N clamping pressure	
All installations	Connections to transformers and contactors		
55 kVA ±6%/±10% 110 kVA ±6%	Main terminals Coil terminals (AF 9-22-00)	M3.5 1.5 Nm M3.5 1.2 Nm Ø 5.5 Pozidriv 2	

110 kVA ±10% 175kVA ±6%/±10% 250 kVA ±6%	Main terminals Coil terminals (AF 26-22-00)	M4.5 2.5 Nm M3.5 1.2 Nm Ø 5.5 Pozidriv 2	
250 kVA ±10% 400 kVA ±6%	Main terminals Coil terminals (A 45-22-00)	M6 4 Nm Ø 6.5 Pozidriv 2 M3.5 1.2 Nm Ø 5.5 Pozidriv 2	
All installations	Surge arrester DEHNGuard DG S 275FM	M6 4 Nm Ø 6.5 Pozidriv 2	

Table 12-1 Power stage components

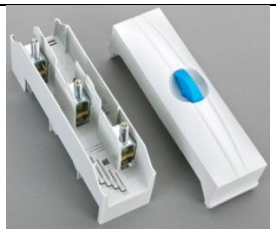
➲ Malfunctions to the LVRSys™ may only be fixed by A. Eberle GmbH & Co. KG.

12.3 Bus system

⚠ CAUTION!	**Destruction of components due to overload!**
	➲ Only tighten/retighten screws to the prescribed torques.

Servicing the bus system:

➲ Check contacts. If necessary, tighten (torque under Table 12-2 Components of the bus system).

Installation	Contact	Torque	Figure
55 kVA ±6%/±10%	NH000	M6 4 Nm ±20% Hexagon socket	
110 kVA ±6%/±10%	NH00	M10 18 Nm ±20% Screw	
	Terminal block up to 50 mm²	M8 10 Nm ±20% Allen size 4	
175 kVA ±6%/±10%	NH1	M10 24 Nm ±20% Screw	

	Terminal block up to 120 mm²	M12 15 Nm ±20% Allen size 4	
250 kVA ±6%/±10%	Switch disconnect-or fuse NH2 up to 1 x 240 mm²	M10 32 Nm	
400 kVA ±6%	Switch disconnect-or fuse NH3 up to 2 x 240 mm²	M12 32 Nm	

Table 12-2 Components of the bus system

➲ Contact A. Eberle GmbH & Co. KG. in the event of malfunctions

Service address:

A. Eberle GmbH & Co. KG
Frankenstraße 160
D-90461 Nuremburg
Telephone: +49 (0)911 628108 – 0
Fax: +49 (0)911 628108 – 96
Email: info@A. Eberle.de

12.4 Spare/Replacement parts

➲ Order replacement parts from manufacturer of A. Eberle GmbH & Co. KG.

The complete product catalogue can be obtained from A. Eberle GmbH & Co. KG.

12.5 Controls

- ➲ Service regularly, at least once a year.
- ➲ Check knurled-head bolts (0.6 Nm).
- ➲ Check plug-in connector with torque (torque under Table 12-3 Tightening torques for plug-in connectors).

Connection	Torque
A1 – X4	M2 0.22 - 0.25 Nm
A1 – X5	M2 0.22 - 0.25 Nm
A1 – X6	M2 0.22 - 0.25 Nm
A1 – X7	M3 0.5 - 0.6 Nm
A2 – X1-X3	M3 0.5 - 0.6 Nm
A2 – X4	M3 0.5 - 0.6 Nm
A3 – X1	M3 0.5 - 0.6 Nm
A3 – X2	M3 0.5 - 0.6 Nm
A3 – X3	M3 0.5 - 0.6 Nm
A5 - A12 – X1 - X5	M3 0.5 - 0.6 Nm

Table 12-3 Tightening torques for plug-in connectors

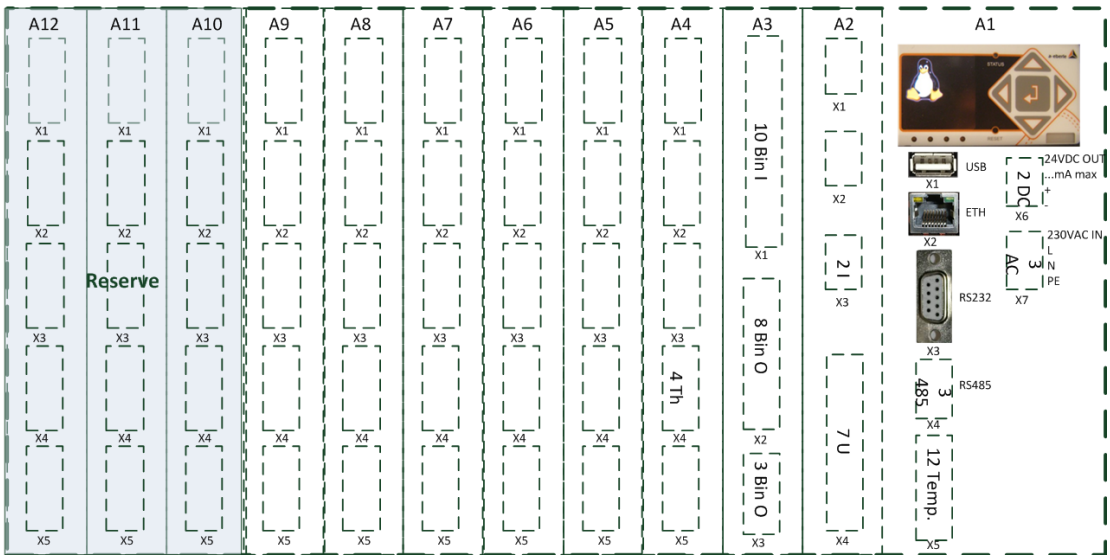


Figure 12-1 Connection plug arrangement for the control units

13. Standards and Laws

- LVD 2014/35/EU
- DIN EN 61439-1 Low-voltage switchgear and controlgear assemblies - Part 1: General rules
- DIN EN 61439-5 Low-voltage switchgear and controlgear assemblies - Part 5: Assemblies for power distribution in public networks
- DIN EN 0298-4 Application of cables and cords in power installations - Part 4: Recommended current-carrying capacity for sheathed and non-sheathed cables for fixed wirings in buildings and for flexible cables and cords
- DIN EN 61000-6-1 Electromagnetic compatibility (EMC) - Part 6-1: Generic standards - Immunity for residential, commercial and light-industrial environments
- DIN EN 61000-6-3 Electromagnetic compatibility (EMC) - Part 6-3: Generic standards - Emission standard for residential, commercial and light-industrial environments
- DIN EN 50160 Voltage characteristics of electricity supplied by public distribution networks
- DIN EN 82079-1 Preparation of instructions for use - Structuring, content and presentation - Part 1: General principles and detailed requirements

14. Disassembly and disposal

DANGER!	**Danger of electric shock!**
	➲ Make sure the LVRSys™ is de-energized before disassembling it.

➲ Make sure the LVRSys™ is de-energized

➲ Remove low voltage cable.

➲ Remove local cabinet grounding.

The disposal of the LVRSys™ will be carried out by A. Eberle GmbH & Co. KG..

➲ All components are to be sent to:

A. Eberle GmbH & Co. KG

Frankenstraße 160

D-90461 Nuremburg

15. Guarantee

A. Eberle GmbH & Co. KG. guarantees that this product and accessories will remain free of defects in material and workmanship for a period of three years from the date of purchase.

This warranty does not cover damage caused by:

- accidents
- misuse
- abnormal operating conditions

To make a claim under this warranty, please contact A. Eberle GmbH & Co KG in Nuremburg, Germany.

Notes

A. Eberle GmbH & Co. KG

Frankenstraße 160
D-90461 Nuremberg

Tel.: +49 (0) 911/62 81 08-0
Fax: +49 (0) 911/62 81 08 96
Email: info@a-eberle.de

http://www.a-eberle.de

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